

MOCK-UPS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This SECTION describes the administrative and procedural requirements for Project mock-ups.

1.02 QUALITY ASSURANCE

A. General Requirements for Mock-Ups:

1. Provide full-size mock-ups using the same products, materials, methods, workmanship, and quality that will be used in the Work. Demonstrate the full range of appearance, aesthetic effects, and quality of workmanship to be provided in the Work. Personnel constructing and assembling mock-up shall be the same as will perform the actual final units of Work using the same means, methods, and techniques to be utilized for final installation on the building.
2. Provide engineered foundations, structural framing, and other supporting and bracing structures and substrates as required for the mock-up. Design and engineering of supporting and bracing structures shall be prepared by a qualified professional engineer, duly licensed in the State of California, utilizing standard engineering methods acceptable to authorities having jurisdiction in compliance with applicable codes and regulations. Finish supporting members as required to prevent corrosion and deterioration. Maintain supporting and bracing structures in good repair for the duration the mock-up is required. Obtain approvals and permits from authorities having jurisdiction as required prior to installation.
3. Notify Owner and Architect in writing not less than seven (7) working days prior to date when mock-ups will be constructed or installed.
4. Obtain Architect's review and acceptance of mock-ups prior to starting fabrication and installation of the Work the mock-up represents. Make modifications, remove unacceptable portions, and provide additional mock-ups as required until the mock-up is accepted.
5. Review and acceptance of mock-ups by the Architect or others shall not constitute approval of deviations from requirements of the Contract Documents that are contained in mock-ups, unless such deviations are specifically accepted in writing in advance by the Architect.
6. Accepted mock-ups will be used as a standard of quality and appearance for the Work the mock-up represents and may not be incorporated into the Work. Maintain accepted mock-up during construction in an undisturbed condition.

B. Exterior Mock-Ups:

1. Mockup No. 1 - Exterior Portland Cement Wall Assembly:

- a. After acceptance of sample panels for finish texture, provide a mock-up of the exterior wall assembly, approximately 12-feet by 12-feet in size, complete with all materials, accessories, and components to demonstrate the full range of appearance, aesthetic effects, and quality of portland cement plaster materials and application to be provided in the Work, including but not limited to:
 - 1) metal wall framing, including a 4-foot by 4-foot portion of double stud framing;
 - 2) gypsum sheathing;
 - 3) building paper and flashing membrane;
 - 4) metal lath, metal accessories, aluminum accessories;
 - 5) metal drift joint;
 - 6) 3-coat plaster with required finish;
 - 7) one aluminum window assembly, 3-feet wide by 3-feet high, within the plaster field; and
 - 8) elastomeric coating in all specified colors with each color placed where directed.
- b. Locate mock-ups on the Site where acceptable to the Owner and Architect for proper viewing.

C. Interior Mock-Ups: Locate each mock-up where acceptable to the Owner and Architect. Refer to various Specification SECTIONS for requirements.

D. Regulatory Requirements: Materials, engineering, and fabrication shall be in compliance with requirements of the applicable building code and other regulations. Refer to SECTION 01 41 00 "REGULATORY REQUIREMENTS" for further information.

1.03 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings for complete exterior wall mock-ups, including provisions for attachment or insertion of associated Work.

1.04 JOB CONDITIONS

A. Schedule construction and review of the mock-ups so as not to delay the progress of the Work.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials and finish shall be as specified in individual Specification SECTIONS, as applicable to the Work.

PART 3 - EXECUTION

3.01 FABRICATION

- A. Fabricate mock-ups in accordance with the accepted Shop Drawings and as specified in individual Specification SECTIONS.

3.02 INCORPORATION IN THE WORK

- A. With the Architect's prior written acceptance, interior mock-ups may be incorporated in the Work.
- B. Exterior mock-ups may not be incorporated in the Work.

3.03 PROTECTION AND MAINTENANCE

- A. Protect and maintain mock-ups in clean, undamaged condition until such time as they are incorporated in the Work or removed from the Site.

3.04 REMOVAL OF MOCK-UPS

- A. Dismantle and remove mock-ups that are not incorporated into the Work from the Site, when acceptable to the Owner and Architect.
- B. Dispose of mockup materials in compliance with regulatory requirements. Recycle eligible materials in compliance with specified requirements.

END OF SECTION

OWNER-FURNISHED PRODUCTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This SECTION describes the requirements for providing associated rough-in and utility connection Work and installing Owner-furnished products.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions obtained from the Owner.
- B. Shop Drawings: Submit Shop Drawings showing details of installation of Owner-furnished products.

1.03 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Receive Owner-furnish products at the Site and immediately inspect for damage.
- B. Store and handle Owner-furnished products in compliance with the manufacturer's printed instructions and in a manner to prevent soiling and other damage.

PART 2 - PRODUCTS

2.01 PRODUCTS TO BE FURNISHED BY THE OWNER FOR INSTALLATION BY THE CONTRACTOR

- A. Owner will:
 - 1. make available manufacturer's literature and shop drawings showing required mounting and rough-in information;
 - 2. furnish standard integral parts of products with the products; and
 - 3. tailgate-deliver items to the Site to coincide with the Contractor's construction schedule.
- B. Contractor shall:
 - 1. coordinate deliveries of Owner-furnished products with the current construction schedule;
 - 2. receive products at the Site and give written receipt for item at time of delivery, noting visible defects or omissions. (If such declaration is not given, the Contractor shall assume responsibility for such defects and omissions.);
 - 3. store products until ready for installation and protect them from loss and damage;
 - 4. unpack products and assemble products when necessary;
 - 5. coordinate product mounting and utility requirements;

6. provide required backing plates utility rough-ins for products where required; and
 7. install products in compliance with manufacturer's printed instructions, recommendations, and accepted Shop Drawings, under the supervision of manufacturer's authorized representative where specified, supplying labor and material required and making mechanical, plumbing, and electrical connections necessary to operate products.
3. Owner-Furnished Products:
- a. As specified in individual SECTIONS of DIVISIONS 02 through 49.
 - b. Products will be compatible with space limitations indicated and with mechanical, plumbing, and electrical services indicated and specified in other DIVISIONS.
4. Rough-in locations, sizes, capacities, and similar type items shall be as indicated and required by product manufacturer.
- a. If the Owner substitutes items similar to those indicated or specified, there shall be no change in rough-in cost, unless substitution occurs after rough-in Work has been completed or rough-in involves other mounting requirements, utilities, or utilities of different capacity from that required by item originally specified.
5. Electrical Work shall comply with applicable requirements of DIVISION 26 - ELECTRICAL.
6. Plumbing Work shall comply with requirements of DIVISION 22 - PLUMBING.
7. Mechanical Work shall comply with requirements of DIVISION 24 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC).

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify that conditions are satisfactory for installation of Owner-furnished products.
- B. Do not begin installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection:
 1. Protect adjacent surfaces and finishes from damage during installation of Owner-furnished products.
 2. Protect products from damage during field handling and installation.
- B. Surface Preparation: Protect Owner-furnished products from corrosion in compliance with the applicable manufacturer's printed instructions.

3.03 INSTALLATION

- A. Install Owner-furnished products plumb and level, where indicated, and in compliance with the applicable manufacturer's printed instructions and accepted Shop Drawings.
- B. Set and secure products, rigidly- or flexibly-mounted, to backing plates as recommended by the manufacturer.
- C. Where products are indicated to be welded to embeds or similar installed supports, welding quality shall comply with applicable specifications specified in SECTION 05 50 00 "METAL FABRICATIONS", and when exposed in the completed Work, shall be smooth, flush and imperceptible.
- D. Provide plumbing, mechanical, and electrical connections as specified in DIVISIONS 22, 23 and 26.
- E. Touch-up and restore damaged or defaced finishes at no additional cost to the Owner.

3.04 ADJUSTING AND CLEANING

- A. Adjust and lubricate moving components as required for proper operation in compliance with the manufacturer's printed instructions.
- B. Upon completion of installation clean products in accordance with manufacturers' printed recommendations.

3.05 PROTECTION

- A. Protect Owner-furnished products from damage and deterioration until time of completion and acceptance by the Owner.

END OF SECTION

SECTION 03 49 00

GLASS-FIBER-REINFORCED CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This SECTION describes the requirements for furnishing and installing glass-fiber-reinforced concrete (GFRC) units, including associated secondary metal framing and embedded and loose connection accessories necessary for handling, erection, support, and attachment of GFRC panels to the building structure. GFRC units include:
 - 1. Column covers.
- B. Water repellent for GFRC panels is specified in SECTION 07 19 00 "WATER REPELLENTS".

1.02 QUALITY ASSURANCE

- A. Source Limitations:
 - 1. Obtain glass-fiber-reinforced concrete from a single GFRC manufacturer.
 - 2. Wherever they will appear in the completed Work, obtain each type of constituent material from the same source to achieve a uniform appearance throughout for each type of GFRC unit required.
- B. Referenced Standards:
 - 1. PCI Manuals: Comply with requirements and recommendations in the following PCI manuals, except comply with more stringent requirements when specified:
 - a. PCI MNL 128 "Recommended Practice for Glass Fiber Reinforced Concrete Panels".
 - b. PCI MNL 130, "Manual for Quality Control for Plants and Production of Glass Fiber Reinforced Concrete Products".
 - 2. AISI Specifications: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members".
 - 3. AISC Specifications: Comply with ANSI/AISC 360 "Specification for Structural Steel Buildings".
- C. Qualifications, GFRC Manufacturer:
 - 1. GFRC manufacturer shall have been continuously engaged in manufacturing and installing glass-fiber reinforced concrete of the types required for not less than ten (10) years prior to the date of this Project, shall be a member of PCI with PCI-Certified Plant for Group G, Glass Fiver Reinforced Concrete per PCI MNL 130, and shall have a source quality control plan in effect prior to the date of this Contract. GFRC manufacturer shall retain responsibility for compliance with specified requirements.

- a. Manufacturer's responsibility includes fabricating and installing GFRC panels and providing professional engineering services needed to assume engineering responsibility for GFRC panels.
 - b. Engineering responsibility includes preparation of Shop Drawings and comprehensive engineering analysis, based on GFRC production test values, by a qualified professional engineer as specified hereinafter.
- 2. Engineer shall be a professional structural engineer experienced in GFRC design of the type required for this Project and licensed in the State of California. Engineer shall be retained and paid directly by the GFRC manufacturer.
- 3. Welders performing structural welding shall be qualified within past year in accordance with AWS D1.1 "Structural Welding Code - Steel" and D1.3 "Structural Welding Code - Sheet Steel". Pay for retesting as required.
- 4. Spray operators shall be trained, experienced, and recommended by the GFRC manufacturer.
- 5. Installers shall be trained, experienced, and recommended by the GFRC manufacturer.
- D. Qualifications, Testing Agency: Testing Agency shall be regularly providing testing services of the type required, as proposed and accepted in advance. Refer to SECTION 01 45 00 "QUALITY CONTROL".
- E. Performance Requirements:
 - 1. Structural Performance:
 - a. Provide GFRC units, including panel frames, anchors, and connections to building structure, capable of withstanding the following loads as well as the effects of thermal- and moisture-induced volume changes, according to load factors and combinations established in PCI MNL 128, "Recommended Practice for Glass Fiber Reinforced Concrete Panels":
 - 1) Design loads as indicated on the Structural Drawings, and as follows:
 - a) Wind loads, positive and negative, for various parts of building.
 - b) Seismic loads, including seismic coefficient and importance factor.
 - 2) Dead loads of GFRC units.
 - 3) Deflection: Design panel frames to withstand design loads without lateral deflections greater than 1/240 of wall span.
 - 4) Thermal Movements: Provide for thermal movements resulting from annual ambient temperature changes of 100 degrees Fahrenheit.

- 5) Design panel frames and connections to accommodate deflections and other building movements.
 - 6) Design panel frames to transfer window loads to building structure.
 - b. Basis of structural design shall include, but is not necessarily limited to:
 - 1) Architectural designs indicated.
 - 2) Building structural design indicated.
 - 3) Properly data generated from GFRC manufacturer's actual production in accordance with PCI MNL 128; and
 - 4) Considerations of lifting, handling, installation, and safety.
 - c. Designs shall be prepared by the qualified engineer specified in Paragraph 1.02, C, 2 utilizing standard engineering methods acceptable to building officials having jurisdiction.
 - d. Substantiate designs by engineering calculations, diagrams, and drawings sufficient to indicate compliance with applicable requirements.
 - e. Connections shall transmit loads or forces from the panels to the centroids of structural members without causing warping or twisting of structural members.
 - f. Design panel frames and connections to accommodate deflections and other building movements.
 - g. Design panel frames to transfer window loads to building structure.
 - 2. Basis of Acceptance of Appearance Characteristics:
 - a. Panel appearance shall be based upon sample panel on file with Architect for each indicated and specified type of finish.
 - b. Prior to submitting samples, cooperate with Owner and Architect to determine specific requirements for coloration, texture, and other appearance characteristics.
- F. Source Quality Control:
- 1. GFRC manufacturer shall have and maintain an established Quality Control program in accordance with PCI MNL 130. Furnish a copy of the program to the Owner and Architect upon request.
 - 2. Testing of materials and inspection of production techniques shall be the responsibility of the GFRC manufacturer.

3. Quality Control program shall monitor glass fiber content, spray rate, unit weight, product physical properties, anchor pull-off and shear strength, and curing period and conditions. Results of such quality-control tests and explanations of such tests shall be available to Owner and Architect upon request.
 4. Prepare test specimens and test in accordance with ASTM C1228, PCI MNL 128, and PCI MNL 130 procedures.
 5. Test GFRC inserts and anchors in accordance with ASTM C1230 to validate design values.
 6. Produce test boards at a rate not less than one per work shift per operator for each spray machine and for each mix design.
 - a. For each test board, determine glass fiber content in accordance with ASTM C1229 and flexural yield and ultimate strength in accordance with ASTM C947.
 7. Maintain quality control records available for Architect's review upon request within two years after date of final acceptance of the Work. Records shall include mix proportions, test reports, inspection reports, and unit identification number along with date cast, shipping records, and erection reports.
- G. Structural Welding Inspection:
1. Required by qualified representative of accepted Testing Agency.
 2. Visually inspect structural welding as the welding Work progresses, as determined by the Testing Agency.
- H. Regulatory Requirements: Glass-fiber-reinforced concrete and its installation shall be in compliance with requirements of the applicable building code and other regulations. Refer to SECTION 01 41 00 "REGULATORY REQUIREMENTS" for further information.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's descriptive and technical data and illustrations, clearly marked to show products and materials proposed for use for both GFRC panels and framing materials.
- B. Shop Drawings:
1. Submit Shop Drawings showing:
 - a. Panel elevations, sections, and dimensions;
 - b. Thickness of facing mix, GFRC backing, and bonding pads for typical panels;
 - c. Finishes;
 - d. Joint and connection details;
 - e. Erection details;

- f. Panel frame details for typical panels including sizes, spacings, thicknesses, and yield strengths for various members;
 - g. Locations and details of connection hardware attached to structure.
 - h. Size, location, and details of flex, gravity, and seismic anchors for typical panels;
 - i. Other items sprayed into panels;
 - j. Erection sequence for special conditions;
 - k. Relationship to adjacent materials;
 - l. Descriptions of loose, cast-in, and field hardware; and
 - m. Location mark schedules.
- 2. Shop Drawings shall be sealed and signed by the accepted engineer.
- C. Structural Design Calculations:
 - 1. Submit three sets of structural design calculations, sealed and signed by the accepted engineer, indicating compliance with structural requirements, including attachment of GFRC panels to building structure.
 - 2. Submit calculations with initial submittal of Shop Drawings.
- D. Qualification Data:
 - 1. Manufacturer: Submit evidence that manufacturer complies with specified qualification requirements.
 - 2. Engineer: Submit evidence of that engineer complies with specified qualification requirements.
 - 3. Welders: Submit welding certificate for each welder performing welding for this Work.
- E. Samples:
 - 1. Materials: Submit samples of individual constituent materials as requested by the Architect.
 - 2. Sample Panels: Submit sample panels, each approximately 24-inches square and of actual thickness, based upon determinations made in cooperation with the Architect. Incorporate adjustments as required by the Architect and resubmit sample panels as required until desired effects are achieved and accepted.

F. Plant Samples:

1. Submit one for type of finish as directed. Provide additional samples as directed.
2. Fabricate in full-size unit suitable for use in the Work at accepted location.
3. Notify Architect and Owner for plant review of completed panel before erecting panels.
4. Erect panel at the plant at a location that will permit viewing in full, and notify Architect for review and acceptance.
5. Remainder of panels of like finish appearance used in the Work shall match sample panel as accepted.

G. Certificates of Compliance: Submit Certificates of Compliance for GFRC constituent materials and primary metal framing components to indicate compliance with specified and referenced requirements. Submit before such materials are used for the Work.

H. Test and Inspection Reports:

1. Submit for GFRC mix designs before commencement of production Work.
2. Submit for GFRC production Work, and for structural welding, as Work progresses, and at intervals determined before commencement of Work.

I. Mix Description: Submit detailed description of GFRC mix used for accepted panels.

1.04 DELIVERY, HANDLING, AND STORAGE

- A. Deliver and handle GFRC units in a position consistent with their shape and design in order to avoid excessive stresses and damage. Support units during shipment on non-staining, shock-absorbing material.
- B. Deliver and handle metal-frame materials or preassembled frames to prevent damage to surfaces and connections.
- C. If panels are nested or stacked, consideration shall be given to transfer of load in order to prevent crushing or other damage.
- D. Lift or support units at designated points.
- E. Place non-staining resilient spacers of even thickness between units.
- F. Protect units from dirt, staining, and physical damage during transportation, handling, and storage.
- G. Store units with nonstaining, resilient supports located in same positions as when transported.
- H. Store units on firm, level, and smooth surfaces with identification marks easily readable.
- I. Store metal-frame materials or preassembled frames adequately supported and above grade.

1.05 COORDINATION

A. Design and Fabrication:

1. Prepare GFRC panels as required for framing system and attachment of anchoring devices.
2. Install GFRC-embedded items as required and supplied as Work of other SECTIONS, and incorporate openings in panels as required for penetrations and other Work.

B. Pre-Installation:

1. Provide GFRC-embedded panel-connection hardware.
2. Furnish panel-connection hardware to be embedded in cast-in-place concrete to the Site along with drawings, templates, and instructions to jobsite as necessary for proper setting of items to be embedded in cast-in-place concrete. Furnish such items in a manner to cause no delay to the Work.

PART 2 - PRODUCTS

2.01 ACCEPTABLE GFRC MANUFACTURERS

A. Subject to compliance with requirements, furnish GRRC units manufactured by one of the following:

1. Clark Pacific, West Sacramento, CA.
2. Dura Art Stone, Inc., Mountain View, CA.
3. Walters & Wolf, Inc., Fremont, CA.

2.02 GFRC MATERIALS

A. Portland Cement: In compliance with ASTM C150, Type I, II, or III, and as follows:

1. Backing Mix: Grey or white.
2. Facing Mix: White, of same type, brand, and source throughout GFRC production.

B. Aggregate:

1. Backing Aggregate: Washed and dried silica sand in compliance with ASTM C144, or accepted equal with a proven history of successful use in GFRC Work with 100 percent passing No. 20 sieve and reasonably free from fines passing No. 200 sieve.
2. Facing Aggregate: Provide types and sizes as required to match appearance of accepted sample panels.

- a. Coarse Aggregate: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match sample; in compliance with ASTM C33, except for gradation and PCI MNL 130; 1/4-inch maximum size.
 - b. Fine Aggregate: Natural sand or sand manufactured from coarse aggregate, in compliance with ASTM C33, except for gradation with a maximum of 5 percent passing No. 100 sieve and a maximum of 3 percent passing No. 200 sieve.
- C. Admixtures:
- 1. General Requirements: Provide admixtures as proposed by GFRC manufacturer and as specified.
 - 2. Air Entraining Admixture: In compliance with ASTM C260, containing not more than 0.1 percent chloride ions.
 - 3. Chemical Admixture: In compliance with ASTM C494, containing not more than 0.1 percent chloride ions.
 - 4. Metakaolin: In compliance with ASTM C618, Class N.
 - 5. Polymer Curing Admixture: Acrylic thermoplastic copolymer dispersion in compliance with PCI MNL 130.
 - 6. Coloring Admixture: In compliance with ASTM C979, synthetic mineral-oxide pigments or colored water-reducing admixtures, temperature stable, nonfading, and alkali resistant; not to exceed 10 percent of cement weight. Furnish colors required to match appearance of accepted sample panels.
- D. Glass Fibers: In compliance with ASTM C1666, alkali resistant, with a minimum zirconia content of 16 percent, length as determined by GFRC manufacturer, specifically produced for use in GFRC.
- E. Water: Potable, clear, and free from deleterious material that may affect color stability, setting, or strength of GFRC and complying with chemical limits of PCI MNL 130.

2.03 METAL FRAMING MATERIALS

- A. General: Requirements: Standard prefabricated light-gauge structural steel framing components as manufactured by Angeles Metal Products, Ceco Corp., Keene Corp., or accepted equal.
- B. Steel Sheet: In compliance with ASTM A1011 (hot-rolled) or ASTM A1008 (cold rolled); nonmetallic coated in compliance with ASTM A1003; of grade required by structural performance of framing.
- C. Studs: Furnish in single-length units only for full-panel height or width where used, unless otherwise indicated or accepted.
 - 1. Type: C-channel, punched web.
 - 2. Thickness: Not less than 0.053-inch thick (nominal 16-gauge) uncoated thickness.

3. Depth: As required.
- D. Runners (Track): Furnish in single-length units only for full-panel height or width where used, unless otherwise indicated or accepted.
1. Type: Open C-channel, unpunched web.
 2. Thickness: Match studs.
 3. Depth: Match studs.
- E. Finish: Manufacturer's standard factory-applied rust-inhibitive primer.
- F. Welding Electrodes: As recommended by framing manufacturer.

2.04 ACCESSORY MATERIALS

- A. Connection Components:
1. Steel Shapes and Plates: in compliance with ASTM A36.
 2. Anchors and Inserts: Steel, in compliance with ASTM A29 or ASTM A108. Yield strength shall conform to design minimum and maximum steel yield strength. Inserts shall be compatible with or isolated from the other materials with which they will come in contact to avoid unwanted chemical or electrochemical reactions. Ductile materials shall be used.
 3. Steel Bars: In compliance with ASTM A108, AISI Grade 1018.
- B. Fastenings:
1. Anchor Bolts: In compliance with ASTM A307 or ASTM A325, with cut washers for bearing nuts not fixed by welding.
 2. Other Fastenings: As required and accepted.
 3. Sizes: As required and accepted.
 4. Finish: Zinc-coated by hot-dip process in compliance with ASTM A153.
- C. Welding Materials and Processes: Appropriate for materials involved, as accepted.
- D. Shop Primer: Themec Co., Inc. "Series 88HS - 555 Red" modified short oil rust inhibitive primer, or accepted equal.
- E. Cleaning and Sealing Agents:
1. As recommended by the GFRC manufacturer.
 2. Types appropriate for respective finish characteristics where used.

F. Mold Materials: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that will provide continuous and true GFRC surfaces within tolerances; nonreactive with GFRC and capable of producing required finish surfaces.

1. Mold-Release Agent: Commercially produced liquid-release agent that will not bond with, stain, or adversely affect GFRC surfaces and will not impair subsequent surface or joint treatments of GFRC.
2. Form Liners: Units of face design, texture, arrangement, and configuration indicated. Provide solid backing and form supports to ensure that form liners remain in place during GFRC application. Use with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect GFRC surfaces and will not impair subsequent surface or joint treatments of GFRC.
3. Surface Retarder: Chemical liquid set retarder capable of temporarily delaying hardening of newly placed GFRC face mix to depth of reveal specified.

2.05 GFRC MIXES

A. General Requirements:

1. In accordance with mix designs determined by manufacturer and substantiated by Testing Agency, and as accepted.
2. Trial mix designs shall include constituent materials, including admixtures and colorants, the same as intended for use in the Work.
3. Each mix type consistent throughout the Work.

B. Backing Mix: As determined and proposed by manufacturer, but generally of a type comprising portland cement, glass fiber, sand, and water; and admixtures and colorant as required. Provide nominal glass-fiber content of not less than 5 percent by weight of total mix.

C. Face Mixes: As determined and proposed by manufacturer and consistent with backing mix, but generally of a type comprising portland cement, fine and coarse aggregates, water, and admixtures and colorant as required to match appearance of accepted sample panels.

1. Air Content: 8 to 10 percent; ASTM C 185.

2.06 GFRC FABRICATION

A. General Requirements:

1. Fabricate panel frames and accessories plumb, square, true to line, and with components securely fastened, in accordance with the accepted Shop Drawings and specified requirements.
 - a. Fabricate panel frames using jigs or templates.
 - b. Cut cold-formed metal framing members by sawing or shearing; do not torch cut.

- c. Fasten cold-formed metal framing members by welding. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding Work.
 - d. Fasten framing members of hollow structural sections, steel channels, or steel angles by welding. Comply with AWS D1.1 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding Work.
 - e. Weld flex, gravity, and seismic anchors to panel frames.
 - f. Reinforce, stiffen, and brace framing assemblies, if necessary, to withstand handling, delivery, and erection stresses. Lift fabricated assemblies in a manner that prevents damage or significant distortion.
- 2. Galvanizing Repair: Touch up accessible damaged galvanized surfaces in accordance with ASTM A780.
 - 3. Paint Repair: Wire brush, clean, and paint accessible weld areas and other damaged surfaces on prime-painted components with same type of shop primer.
- B. Molds:
- 1. Construct molds that will result in finished GFRC complying with profiles, dimensions, and tolerances indicated by the Contract Documents and accepted Shop Drawings without damaging GFRC during stripping. Construct molds to prevent water leakage and loss of cement paste.
 - 2. Coat contact surfaces of mold with form-release agent in compliance with the manufacturer's printed instructions.
 - 3. Coat contact surfaces of molds with surface retarder for GFRC surfaces to receive exposed-aggregate finish.
 - 4. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during GFRC application. Coat form liner with form-release agent.
- C. Proportioning and Mixing:
- 1. Proportioning and Mixing: For backing mix, carefully meter sand/cement slurry and glass fibers to spray head at rates to achieve design mix proportions and glass-fiber content according to PCI MNL 130 procedures.
 - 2. Maintain cleanliness of equipment and working procedures.
- D. Spray Application:
- 1. Spray mist coat consisting of the matrix without glass fiber over molds to a nominal thickness of 1/8-inch on planer surfaces.
 - 2. Spray or place face mix in thickness indicated on Shop Drawings.

3. Proceed with spray-up of backing mix before mist coat has set using procedures that produce a uniform thickness and distribution of glass fiber and cement matrix.
 4. Consolidate backing mix by rolling or other technique to achieve complete encapsulation of glass fibers and compaction.
 5. Measure thickness with a pin gauge or other accepted method for at least each 5 square feet of panel surface. Take not less than six measurements per panel.
- E. Hand form and consolidate intricate details, incorporate formers or infill materials, and over spray before material reaches initial set to ensure complete bonding.
- F. Attach panel frame to GFRC before initial set of GFRC backing, maintaining a minimum clearance of 1/2-inch from GFRC backing, and without anchors protruding into GFRC backing.
- G. Build up homogeneous GFRC bonding pads over anchor feet, maintaining a minimum thickness of 1/2-inch over tops of anchor feet, before initial set of GFRC backing.
- H. Inserts and Embedments: Build up homogeneous GFRC bosses or bonding pads over inserts and embedments to provide sufficient anchorage and embedment to comply with design requirements.
1. Properly embed inserts in built-up homogeneous GFRC bosses to develop their strength.
 2. Encapsulated inserts shall protrude slightly above the surface of the GFRC. Waste material such as overspray is not acceptable to encapsulate inserts.
 3. Rigid embedded items bonded to GFRC panels shall not create undesirable restraint to volume changes.
- I. Curing: Employ initial curing method that will ensure sufficient strength for removing units from mold. Comply with PCI MNL 130 procedures.
1. After initial curing, remove panel from mold and place in a controlled curing environment.
 2. Keep GFRC panels continuously moist for a minimum of seven days unless polymer-curing admixture was used. Maintain temperature between 60 and 120 degrees Fahrenheit during this period.
- J. Finishes:
1. Exposed Surfaces: Provide light sandblast finish using abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces matching color, texture, and appearance of accepted samples. Finish shall be uniform in appearance and free from mold marks, joint marks, grain marks, linear and directional effects, and other irregularities and defects.
 2. Concealed Surfaces and Flanges: Provide smooth troweled finish.

K. Panel Identification: Mark each unit on backside in accordance with location mark schedule and with date of manufacture.

L. Fabrication Dimensional Tolerances:

1. General: Dimensional tolerance of each completed GFRC unit shall comply with the following dimensional tolerances, as applicable to the Work. For dimensional tolerances not listed below, comply with PCI MNL 130.
2. Overall Height and Width of Units, Measured at the Face Adjacent to Mold at the time of spray-up:
 - a. 10-feet or under, plus or minus 1/8-inch.
 - b. More than 10-feet, plus or minus 1/8-inch per 10-feet; 1/4-inch maximum.
3. Thickness:
 - a. Edge Return Thickness: Plus 1/2-inch, minus 0-inch.
 - b. Architectural Facing Thickness: Plus 1/8-inch, minus 0-inch.
 - c. Backing Thickness: Plus 1/4-inch, minus 0-inch.
 - d. Panel Depth from Face of Skin to Back of Panel Frame or Integral Rib: Plus 3/8-inch, minus 1/4-inch.
 - e. Angular Variation of Plane of Side Mold: Plus or minus 1/32-inch per 3-inches of depth or plus or minus 1/16-inch total, whichever is greater.
 - f. Variation from Square or Designated Skew (Difference in Length of Two Diagonal Measurements): Plus or minus 1/8-inch per 72-inches or plus or minus 1/4-inch total, whichever is greater.
 - g. Local Smoothness: 1/4-inch per 10-feet.
 - h. Bowing: Not to exceed L/240 unless unit meets erection tolerances using connection adjustments.
 - i. Length and Width of Blockouts and Openings within One Unit: Plus or minus 1/4-inch.
 - j. Maximum Permissible Warpage of One Corner out of the Plane of the Other Three: 1/16-inch per 12-inches of distance from nearest adjacent corner.
 - k. Increased tolerances may be permitted at change in plane, radius sections, and stiffening ribs.

M. Position Tolerances: Measured from datum line locations, as indicated on Shop Drawings.

1. Panel Frame and Track: Plus or minus 1/4-inch.
2. Flashing Reglets at Edge of Panel: Plus or minus 1/4-inch.

3. Inserts: Plus or minus 1/2-inch.
4. Special Handling Devices: Plus or minus 3-inches.
5. Location of Bearing Devices: Plus or minus 1/4-inch.
6. Blockouts: Plus or minus 3/8-inch.

N. Panel Frame Tolerances:

1. Vertical and Horizontal Alignment: 1/4-inch per 10-feet.
2. Spacing of Framing Member: Plus or minus 3/8-inch.
3. Squareness of Frame: Difference in length of diagonals of 3/8-inch.
4. Overall Size of Frame: Plus or minus 3/8-inch.

2.07 FABRICATION OF CONNECTION COMPONENTS

- A. Fabricate connection components in required configurations in compliance with the accepted Shop Drawings.
- B. After fabrication, shop clean and shop-prime-paint units, except for surfaces to be embedded in cementitious materials.
- C. Where units are to be welded, prime painting may be delayed until completion of welding.

2.08 FABRICATION OF METAL FRAMES

- A. Fabricate frames in compliance with the accepted Shop Drawings.
- B. Frames may be preassembled units or field assembled provided that intended results are achieved.
- C. After completion of welding and inspection, clean and prime paint welds and other areas where prime coat is scratched, abrades, or otherwise damaged.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify that conditions are satisfactory for the installation of GFRC panels.
- B. Do not begin installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General Requirements:
 1. Install GFRC panels in compliance with the manufacturer's printed instructions, accepted Shop Drawings, and as specified.

2. Provide methods and equipment necessary for safe and efficient field handling and erection.
 3. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanently connected into place.
 4. Lift GFRC panels and install without damage.
- B. Install clips, hangers, fastenings, and provide field welding when required, in compliance with accepted Shop Drawings and by standard methods.
- C. Install GFRC panels plumb, level, square, and in alignment with other GFRC units and adjacent Work. Provide temporary supports and bracing as required to maintain position, stability, and alignment of panels until permanent connections are completed.
1. Maintain horizontal and vertical joint alignment and uniform joint width.
 2. Remove projecting hoisting devices.
- D. Connect GFRC panels in position by bolting or welding, or both, as indicated on the accepted Shop Drawings. Remove temporary shims, wedges, and spacers as soon as possible after connecting is completed.
- E. Welding: Comply with applicable AWS D1.1 and AWS D1.3 requirements for welding, appearance, quality of welds, and methods used in correcting welding Work.
1. Protect GFRC panels from damage by field welding or cutting operations, and provide noncombustible shields as required.
- F. At bolted connections, use lock washers or other acceptable means to prevent loosening of nuts.
- G. Erection Tolerances:
1. General:
 - a. Erected GFRC panels shall meet specified requirements, applicable to the Work.
 - b. Location tolerances shall be non-cumulative.
 2. Face Width of Joints: Plus/minus 3/16-inch.
 3. Warpage: Maximum permissible warpage of one corner out of the plane of the other three shall be 1/16-inch per foot of distance from nearest adjacent corner, or 1/8-inch total after installation.
 4. Bowing: Not over $L/360$, where L is panel length.

3.03 CLEANING AND REPAIRS

- A. Cleaning: Clean exposed panel faces as necessary, using materials, tools, and equipment as recommended in writing by the GFRC manufacturer. Clean soiled GFRC surfaces with detergent and water, using soft fiber brushes and sponges, and rinse with clean water. Prevent damage to GFRC surfaces and staining of adjacent materials.
- B. Repairs:
 - 1. Repairs to GFRC will be permitted provided structural adequacy of the GFRC panel and appearance are not impaired, as approved in writing by the Architect. Mix patching materials and repair GFRC so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces.
 - a. Remove damaged GFRC panels when repairs do not comply with requirements and provide new acceptable Work at no increase in Contract Amount or Contract Time.
 - 2. Prepare and repair accessible damaged galvanized coatings with galvanizing repair paint in compliance with ASTM A780.

3.04 COMPLETION

- A. When complete, each GFRC panel shall be set square, plumb, and level, accurately aligned to position intended, and securely anchored to prevent movement.
- B. Exposed surfaces shall be clean and free from cracks, chips, scratches, dents, tool marks, stains, discoloration, and other defects or damage.
- C. Finish and texture shall match accepted samples. Corrections, if required, shall not be apparent in the completed Work.
- D. Panels shall be ready to receive water repellent and joint sealants.

3.05 PROTECTION

- A. Protect GFRC panels from damage and deterioration until time of completion and acceptance by the Owner.
- B. Do not allow construction activity or traffic near GFRC panels without adequate protection.

END OF SECTION

SHOP-APPLIED COATINGS FOR METAL

PART 1 – GENERAL

1.01 DESCRIPTION

- A. This SECTION describes the requirements for providing shop-applied resinous coatings for aluminum extrusions, aluminum panels, and aluminum coils.
- B. Metal items to receive shop-applied coatings are specified in various individual Specification SECTIONS including but not necessarily limited to:
 - 1. SECTION 07 60 00 "FLASHING AND SHEET METAL".
 - 2. SECTION 07 95 13 "EXPANSION JOINT COVER ASSEMBLIES".
 - 3. SECTION 08 41 13 "ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS".
 - 4. SECTION 08 91 00 "LOUVERS".
 - 5. SECTION 05 58 13.10 "METAL COLUMN COVERS".
- C. Shop-applied primers for field-applied paints are specified in various individual Specification SECTIONS.

1.02 QUALITY ASSURANCE

- A. Source Limitations for Each Type of Coating:
 - 1. Obtain each coating through one source from a single coating formulator.
 - 2. Obtain each color from one production run or color lot.
- B. Specified Coating Formulator: Products of PPG Industries, Inc. are specified to establish a standard of quality, design, and performance. Provide specified products or, subject to compliance with specified requirements, accepted equal product manufactured by Akzo Nobel, BASF Corp., Becker Industrial Coatings; Rohm and Haas, or Valspar Corp. or other accepted equal qualified coating formulator.
- C. Qualifications:
 - 1. Coating Formulator: Coating formulator shall be licensed or otherwise authorized by the resin manufacturer.
 - 2. Applicator: Applicator shall be licensed or otherwise authorized in writing by the coating formulator.
- D. Performance Requirements
 - 1. Fluoropolymer Coatings on Aluminum Extrusions and Panels: In compliance with AAMA 2605 "Voluntary Specification, Performance Requirements, and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels" except as otherwise specified hereinafter.

2. Fluoropolymer Coatings on Aluminum Coil Substrates: In compliance with AAMA 620 "Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Aluminum Substrates" except as otherwise specified hereinafter.
- E. Regulatory Requirements: Materials and application shall be in compliance with requirements of the applicable building code and other regulations. Refer to SECTION 01 41 00 "REGULATORY REQUIREMENTS" for further information.

1.03 SUBMITTALS

- A. Product Data: Submit coating formulator's specifications and descriptive and technical data for each type of coating, clearly marked to show specific products and materials involved.
- B. Color Samples: Submit samples as specified in Specification SECTIONS where shop applied coatings for metal are required.
- C. Certificate of Compliance: Submit coating formulator's written certification that fluoropolymer coatings contain specified polyvinylidene fluoride resins and meet specified performance requirements.
- D. Applicator's Qualifications: Submit evidence that applicator complies with specified requirements.
- E. Maintenance Data: Furnish to the Owner a bound maintenance manual with coating formulator's complete printed product and maintenance information for each coating system. Include:
1. Complete information for all products, materials, colors, and sheens used in the Work.
 2. 8-1/2 inch by 11-inch full-page color sample of each coating, color, and sheen used in the Work. Each sample shall include the coating system, substrate, and locations where the color was used.
 3. MSDS for each coating system.
 4. Copies of manufacturer's warranties.

1.04 WARRANTIES

- A. Coatings on Aluminum Extrusions and Panels:
1. General: Coating formulator shall warrant that the shop-applied coatings on aluminum extrusions and plate will meet the specified requirements for color retention, gloss retention, and film adhesion for not less than twenty (20) years, non-pro-rata, from the date of Substantial Completion and that the coating has a life expectancy of not less than twenty-five (25) years.
 - a. Adhesion: Coating will not crack, check, or peel when measured in accordance with ASTM G23.
 - b. Chalking: Will not exceed No. 8 rating for colors and No. 6 rating for whites when measured in accordance with ASTM D4214 on exposed unwashed surfaces.

- c. Fading: Not more than 5 Delta E units (Hunter) of color change as calculated in accordance with ASTM D2244 on exposed surfaces after cleaning with clean water and a soft cloth.
 2. Warranty does not cover normal weathering.
 3. Warranty period shall begin on date of Substantial Completion.
 4. Furnish warranty to Owner as specified in applicable SECTION of DIVISION 01 - GENERAL REQUIREMENTS.
- B. Coatings on Aluminum Coil Substrates:
1. General: Coating formulator shall warrant that the shop-applied coatings on aluminum coils will meet the specified requirements for color retention, gloss retention, and film adhesion for not less than ten (10) years, non-pro-rata, from the date of Substantial Completion.
 - a. Adhesion: Coating will not crack, check, or peel when measured in accordance with ASTM G23.
 - b. Chalking: Will not exceed No. 8 rating for colors and No. 6 rating for whites when measured in accordance with ASTM D4214 on exposed unwashed surfaces.
 - c. Fading: Not more than 5 Delta E units (Hunter) of color change as calculated in accordance with ASTM D2244 on exposed surfaces after cleaning with clean water and a soft cloth.
 2. Warranty does not cover normal weathering.
 3. Warranty period shall begin on date of Substantial Completion.
 4. Furnish warranty to Owner as specified in applicable SECTION of DIVISION 01 - GENERAL REQUIREMENTS.

PART 2 – PRODUCTS

2.01 SHOP-APPLIED RESINOUS (FLUOROPOLYMER) COATING FOR ALUMINUM EXTRUSIONS AND PANELS

- A. Product: PPG Industries, Inc. "Duranar XL" three-coat, thermo-curing high performance polyvinylidene fluoride (PVDF) organic coating system consisting of primer, barrier, metallic color coat, and clear topcoat in compliance with AAMA 2605, or accepted equal. Coating system shall be formulated under license from the resin manufacturer and shall contain not less than seventy percent (70%) Arkema, Inc. "Kynar 500" or Solvay Solexis, Inc. "Hylar 5000" resin by weight in color and clear coats.
- B. Minimum Dry Film Thicknesses (per ASTM D1400):
 1. Primer Coat: 0.25-mil, plus or minus 0.05-mil.
 2. Color Coat: Not less than 1.00-mil.

- 3. Clear Topcoat: 0.60-mil, plus or minus 0.20-mil.
- 4. Total Thickness: Not less than 1.70-mils.
- C. Specular Gloss of Final Coat: Medium per AAMA 2605.
- D. Hardness: Minimum "F" pencil hardness with no rupture of coating per ASTM D3363.
- E. Formability: Flexible to metal failure of coating when bent 180 degrees around a 1/8-inch mandrel in accordance with ASTM D1737.
- F. Colors: As noted in SECTION 09 00 00 "FINISHES".
- G. Protection: Protect finish with strippable plastic film.

2.02 COIL-COATED RESINOUS (FLUOROPOLYMER) COATINGS FOR ALUMINUM

- A. Product: PPG Industries, Inc. "Duranar XL Plus" three-coat, thermo-curing high performance polyvinylidene fluoride (PVDF) organic coil coating system consisting of urethane primer, color coat, and clear topcoat in compliance with AAMA 620 and THE performance requirements of AAMA 2605, or accepted equal. Coating system shall be formulated under license from the resin manufacturer and shall contain not less than seventy percent (70%) Arkema, Inc. "Kynar 500" or Solvey Solaxis, Inc. "Hylar 5000" resin by weight in color and clear coats.
- B. Minimum Dry Film Thicknesses (per ASTM D1400):
 - 1. Primer Coat: 0.80-mil, plus or minus 0.05-mil.
 - 2. Color Coat: 0.80-mil, plus or minus 0.05-mil.
 - 3. Clear Topcoat: 0.080-mils, plus or minus 0.05-mil.
 - 4. Total Thickness Range: 2.25- to 2.55-mils.
- C. Specular Gloss of Final Coat: 25 to 35 on 60 degree gloss meter per ASTM D523.
- D. Hardness: Minimum "F" pencil hardness with no rupture of coating per ASTM D3363.
- E. Flexibility: 0 T-bend, no pick-off per ASTM D4145.
- F. Colors: As noted in SECTION 09 00 00 "FINISHES".
- G. Protection: Protect finish with strippable plastic film.

2.03 FIELD TOUCH-UP MATERIALS

- A. Aluminum Extrusions and Panels: Product or system in compliance with AAMA 2605, matching original finish for color and gloss, as recommended in writing by the coating formulator.
- B. Aluminum Coils: Product or system in compliance with AAMA 620, matching original finish for color and gloss, as recommended in writing by the coating formulator.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Verify that conditions are satisfactory for the application of shop-applied coatings.
- B. Do not begin application until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Pre-treat metal surfaces with coating formulator's multi-stage cleaning and pretreatment process to remove organic and inorganic surface soils and residual oxides and apply a chemical conversion coating to which organic coating will firmly adhere.

3.03 APPLICATION

- A. Aluminum Extrusions and Panels:
 - 1. Shop-apply coatings by spray application in compliance with the coating formulator's printed instructions and recommendations, and as specified.
 - 2. Apply coatings in the same direction as will be used in the Work to ensure that graining and color will be consistent throughout the Work.
 - 3. Shop apply and process coating after Work is fabricated.
- B. Aluminum Coils: Shop-apply and process coatings to both sides of aluminum coils prior to fabrication.

3.04 COMPLETION

- A. When complete, shop-coated metal surfaces shall match accepted samples and shall be uniform in thickness and color, smooth, and free from skips, runs, laps, holidays, blisters, swelling, nicks, scratches, and other imperfections in the coating that might impair the serviceability or detract from the general appearance of the finished surface as judged by the Architect when viewed at a distance of 5-feet at an angle of 90 degrees to the surface under normal lighting conditions.

3.05 FINISH TOUCH-UP

- A. Touch up is specified in individual Specifications SECTIONS where shop-applied coatings are required.

3.06 PROTECTION

- A. Protect shop-applied coatings from damage and deterioration, other than normal weathering, until time of completion and acceptance by the Owner.

END OF SECTION

METAL COLUMN COVERS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This SECTION describes the requirements for furnishing and installing metal column covers complete with associated metal support framing, attachments, and hardware necessary for complete installations.

1.02 QUALITY ASSURANCE

- A. Regulatory Requirements: Materials and installation shall be in compliance with requirements of the applicable building code and other regulations. Refer to SECTION 01 41 00 "REGULATORY REQUIREMENTS" for further information.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's descriptive and technical data and illustrations, clearly marked to show specific products, materials, finishes, and evidence of compliance with specified requirements. Include manufacturer's printed installation instructions.
- B. Shop Drawings: Submit large-scale Shop Drawings showing locations of covers, plans, elevations, sizes, joint locations, general features, materials, finishes, and details of relationship to adjacent Work, and method of anchoring and attachment to supporting Work.
- C. Samples: Submit samples, each not less than 6-inches by 6-inches in size, of specified metal with specified finish.
- D. Finish Warranty: Submit review copy of manufacturer's proposed finish warranty.
- E. Maintenance Data: Furnish manufacturer's printed recommendations for the care and cleaning of metal column covers and finishes to the Owner.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products in manufacturer's standard protective wrappings and packaging to prevent twisting, bending, abrasion, deformation, and other damage and deterioration. Packaging shall be properly labeled with manufacturer's labels for identification and installation purposes and labels shall be intact and legible. Maintain protective coverings in place and in good repair until removal is necessary.
- B. Store products inside enclosed storage facilities or enclosed building, elevated above concrete slabs in a clean, dry, secure location, protected from construction activities, until ready for use in the Work. Store products in position to prevent temporary and permanent bending and other deformation. Maintain storage spaces and products dry and within temperature and humidity ranges recommended by the manufacturer. Do not store materials with strippable film exposed to sunlight.
- C. Comply with additional requirements of the manufacturer and AAMA "Care and Handling of Architectural Aluminum from Shop to Site".

1.05 FIELD MEASUREMENTS

- A. Prior to fabrication of covers, obtain accurate field measurements to determine dimensions required and show on final Shop Drawings.

1.06 PVDF FINISH WARRANTY

- A. General: Furnish to Owner a written warranty, executed by an authorized officer of the manufacturer, stating that the factory PVDF finish, under normal conditions, will perform within the following requirements for the duration of the warranty.
 - 1. Adhesion: Coatings will not crack, check, or peel when measured in accordance with ASTM G23.
 - 2. Chalking: Will not exceed No. 8 rating for colors and No. 6 rating for whites when measured in accordance with ASTM D4214 on exposed unwashed surfaces.
 - 3. Fading: Not more than 5 Delta E units (Hunter) of color change as calculated in accordance with ASTM D2244 on exposed surfaces after cleaning with clean water and a soft cloth.
- B. During warranty period, satisfactorily repair defective finish. Remove Work with defective finish that cannot be satisfactorily repaired and provide new acceptable Work. Repairs and replacement Work shall match original undamaged Work in all aspects. Perform warranty Work at no cost to the Owner.
- C. Warranty period shall be twenty (20) years from the date of Substantial Completion.
- D. Finish warranty shall be in addition to, and not a limitation of, other rights Owner may have under the Contract Documents.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Basis-of-Design Metal Column Cover: Fry Reglet Corp. "Series KS Key Slot Connection" as follows, or accepted equal.
 - 1. Sizes: As indicated.

2.02 MATERIALS

- A. Covers: Roll-formed aluminum sheet, AA 5005-H32 alloy-temper, not less than 0.125-inch thick. Provide 1/2-inch thick sprayed-on sound deadening insulation as recommended by the cover manufacturer on concealed surfaces.
- B. Concealed Supporting Construction: Light gauge metal framing as specified in SECTION 09 22 16 "NON-STRUCTURAL METAL FRAMING". Provide sizes and gauges as recommended by the column cover manufacturer to suit job conditions.

C. Coatings:

1. Protective Coating: Cold-applied asphalt mastic in compliance with ASTM D1187, Type II and regulatory requirements, compounded for 15-mil dry film thickness per coat. Provide inert-type, non-corrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
2. Field Touch-Up Coating: Coating manufacturer's recommended VOC-compliant air-drying product or system meeting AAMA 2605 and matching color and sheen of factory-applied finish.

D. Fasteners, Attachments, and Anchors:

1. General Requirements:
 - a. Provide types, sizes, and gauges best-suited for purpose as indicated and recommended in writing by the manufacturer for complete installations.
 - b. Fabricate fasteners, attachments and anchors from zinc-plated carbon steel.
 - c. Provide self-locking types to prevent loosening of the Work.
2. Expansion Bolts: Hilti, Inc. "Kwik Bolt TZ", or accepted equal, of sizes and lengths suitable to job conditions, fabricated from AISI Type 304 stainless steel.

2.03 FABRICATION

A. General Requirements:

1. Accurately shop-form covers from specified material and roll-formed to shapes and configurations required in accordance with the accepted Shop Drawings and as specified.
2. Fabricate covers for easy removal and reinstallation without visible fasteners.

B. Metal Support Framing and Attachment Hardware: Fabricate framing and hardware to required shapes and sizes from hot-dipped galvanized steel. Furnish complete with required reinforcements and mounting brackets.

C. Covers:

1. Vertical Edges: Return vertical edges of adjacent cover sections to produce soft vee hairline butt joints between mating edges. Return vertical edges of adjacent cover sections to produce reveal joints between mating edges. Equip edges with mechanical key-slot or other acceptable means to hold sections firmly in place. Uniformly locate vertical joints to minimize appearance as indicated, or as proposed and accepted.
2. Horizontal Edges: Furnish covers in lengths to minimize number of horizontal joints and to correspond to locations of required reveals. Return horizontal edges of adjacent cover sections to produce tight-fitting flush butt joints between mating edges. Equip with factory attached alignment plates and mechanical means to hold sections securely in place.

3. Top Edge: Flush to soffit.
 4. Base: Flush to concrete base, as indicated.
- D. Aluminum Finishes:
1. Exposed: Polyvinylidene fluoride (PVDF) finish as specified in SECTION 05 05 13 "SHOP-APPLIED COATINGS FOR METAL" in custom color to match elastomeric paint color ELP-1. Protect finish with a factory-applied strippable film.
 2. Concealed: Mill finish.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify that conditions are satisfactory for the installation of metal column covers.
- B. Do not begin installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection:
 1. Protect adjacent surfaces and finishes from damage during installation of metal column covers and associated Work.
 2. Protect products from damage during field handling and installation.
- B. Surface Preparation:
 1. Aluminum in Contact with Cementitious Surfaces: Protect nonferrous-metal surfaces that will be in contact with concrete from corrosion with an application of protective coating.
 2. Dissimilar Metals: Comply with AAMA 101, Appendix Dissimilar Materials by separating aluminum materials and other corrodible surfaces from sources of corrosion or electrolytic action contact points.
 3. Strippable Film: Remove strippable film prior to installation. Do not allow film to remain in extreme cold, heat, or in direct sunlight.

3.03 INSTALLATION

- A. Install metal column covers plumb and true-to-line and position in compliance with the manufacturer's printed instructions, accepted Shop Drawings, as indicated, and as specified.
- B. Install support framing and attachment hardware and securely fasten to supporting structure to prevent movement.
- C. Install metal covers between the post structures and engage interlocks of adjoining cover sections. Form tight joints, accurately and uniformly fitted together.

3.04 CLEANING

- A. After installation, clean and polish exposed surfaces and leave them free of foreign materials, smudges, fingerprints, and smears in compliance with the manufacturer's printed recommendations without damaging finish.

3.05 FINISH TOUCH UP AND REPAIRS

- A. Prepare surfaces and touch-up minor scratches and other minor defects with field touch-up coating in compliance with the manufacturer's printed instructions, matching factory finish for color and gloss. Only minor defects will be allowed to be touched up.
- B. Remove components that have been damaged or have deteriorated beyond successful repair by means of touch-up or similar minor repair procedures and provide new replacement components at no increase in Contract Sum or Contract Time.
- C. Upon completion there shall be no evidence of damage or repairs when viewed at a distance of 5-feet.

3.06 COMPLETION

- A. When complete, metal column covers shall be set plumb and level, true-to-line and position, accurately aligned with adjacent Work, and securely attached to supporting Work to prevent movement.
- B. Exposed surfaces shall be clean and free from scratches, dents, tool and fabrication marks, stains, discoloration, and other defects and damage.

3.07 PROTECTION

- A. Protect column covers from damage and deterioration until time of completion and acceptance by the Owner.
- B. Maintain column covers in clean condition until accepted.
- C. Do not allow construction traffic or activity near column covers without adequate protection.

END OF SECTION

SECTION 06 20 00

FINISH CARPENTRY

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This SECTION describes the requirements for furnishing and installing finish carpentry Work.
- B. Finish Carpentry Work includes, but is not necessarily limited to:
- ~~1. Custom design built-in upholstered seating.~~
 - ~~2.1.~~ Custom laminated-wood benches with metal supports.
 - ~~3. Custom design wall- and floor-mounted wood benches with metal supports.~~
 2. Plastic laminate-covered composite core wall protection panels (WPP-3 as described in SECTION 10 26 10 "WALL AND CORNER GUARDS").
 - ~~4.3.~~ Miscellaneous millwork and interior wood trim.
 - ~~5.4.~~ Associated fire-retardant treatment.
- C. ~~Other p~~Plastic laminate-clad casework is specified in SECTION 06 41 16 "PLASTIC LAMINATE-CLAD ARCHITECTURAL CABINETS" and in SECTION 12 35 55 "LABORATORY AND PHARMACY SYSTEM CASEWORK".

1.02 QUALITY ASSURANCE

- A. Source Limitations: Furnish finish carpentry Work from a single fabricator-installer.
- B. Reference Standard: Materials, fabrication, and installation of finish carpentry Work shall be in compliance with the standards of the latest edition of the "Architectural Woodwork Standards" manual (hereinafter called "AWS Manual"), a joint publication of the Architectural Woodwork Institute (AWI), the Woodwork Institute (WI), and the Architectural Woodwork Manufacturers Association of Canada (AWMAC), for the following quality grades:
1. Fabrication: Custom. Economy grade as allowed by the AWS Manual, is not acceptable for any portion of the Work.
 2. Installation: Premium.
- C. Qualifications:
- ~~1. Engineer: Professional engineer duly licensed in the State of California. Engineer shall be retained and paid by the Fabricator-Installer.~~
 - ~~2.1.~~ Fabricator-Installer:
 - a. Fabricator-Installer shall have not less than five (5) years' experience in the fabrication and installation of finish carpentry Work of the types required for this Project and shall have completed prior jobs of comparable extent, complexity, and quality, produced in compliance with the requirements of the AWS Manual or the WI "Manual of Woodwork", to that indicated and specified for this Project.

- b. Fabricator-Installer is not required to be a licensee of the Woodwork Institute.
- c. ~~Fabricator-Installer shall assume responsibility for engineering of built-in seating reinforcement and attachment to supporting Work.~~

~~D.~~ Built-in Seating and Bench Attachment Design Criteria:

- 1. ~~Design of built-in seating and bench attachment locations and attachment of seating to supporting Work shall be prepared by the qualified engineer specified hereinbefore in Paragraph 1.02, C, 1 and shall utilize standard engineering methods acceptable to OSHPD in compliance with requirements of CCR Title 24, Part 2, Volume 2, Chapter 16A Structural Design.~~
- 2. ~~Engineer seating area to support a live load of not less than 300 pounds per square foot without visible bow and with deflection limited to L/360.~~
- 3. ~~Substantiate designs by engineering calculations, diagrams, and drawings sufficient to show compliance with specified requirements.~~
- 4. ~~Connections shall transmit loads or forces from the seats and benches to supporting Work without causing warping or twisting of support members.~~

~~E.~~ Fabrication and Installation Quality Control:

- 1. ~~Comply with provisions of the WI "Certified Compliance Program (WI-CCP)".~~
 - a. ~~Shop Drawings, fabricated products, factory finishing, and installation shall inspected by the WI or a WI Licensee to ensure compliance with requirements of the Drawings, Specifications, and the AWS Manual for specified grades.~~
 - b. ~~For inspections performed by a WI Licensee where non-compliant conditions are suspected, the Owner, Architect, Contractor, or a supplier may submit a written request to the WI for reinspection. WI shall promptly re-inspect the Work in question and furnish a written report detailing non-compliant conditions found to exist to the Owner, Contractor, Architect, and WI Licensee. WI reinspection service shall be performed under provisions of the WI CCP.~~
- 2. ~~Include all costs and fees for complying with the requirements of the WI CCP.~~

~~F.D.~~ Regulatory Requirements:

- 1. General Requirements: Materials, fabrications, and installation shall be in compliance with requirements of the applicable building code and other regulations. Refer to SECTION 01 41 00 "REGULATORY REQUIREMENTS" for further information.
- 2. Fire-Test Response Characteristics:
 - a. Fire-Retardant Composite Core Panels: When fire-retardant core material is tested in accordance with ASTM E84, Flame Spread Index shall be 25 or less and Smoke Developed Index shall be 50 or less.

b. Fire-Retardant Treated Wood: When fire-retardant treated wood is tested in accordance with ASTM E84, Flame Spread Index shall be 25 or less and Smoke Developed Index shall be 450 or less.

c. ~~Upholstery Components: Foam, Dacron wrap, upholstery, non-slip pad, and similar materials shall be in compliance with requirements of California Technical Bulletin 117 for Class 1.~~

3. ~~Built-in Seating Seismic Fabrication and Attachment Criteria: Design of built-in seating attachment locations and attachment of seating to supporting Work to resist gravity and seismic loads shall be prepared by the qualified engineer specified in Paragraph 1.02, C, 1 and shall include a comprehensive engineering analysis utilizing standard engineering methods acceptable to OSHPD in compliance with requirements of CCR Title 24, Part 2, Volume 2, Chapter 16A Structural Design.~~

a. ~~Attachment methods shall lend themselves to rational structural analysis demonstrated by calculations. Substantiate designs by engineering calculations, diagrams, and drawings sufficient to show compliance with specified requirements.~~

b. ~~Connections shall transmit loads or forces from the built-in seating to supporting Work without causing warping, twisting, deformation, or damage to support members.~~

c. ~~Refer to SECTION 01 73 23 "BRACING AND ANCHORING" for additional information.~~

4.3. Formaldehyde Emissions Limit - Composite Wood Products:

a. Formaldehyde emissions of composite wood products including hardwood plywood, medium density fiberboard, and particleboard shall not exceed current limits established by the California Air Resources Board (CARB).

b. Each unit of Work using composite wood products (e.g. bench, panel, etc.) shall be labeled to indicate compliance with requirements. Label shall be applied as a stamp, tag, sticker, or bar code and shall include the fabricator's name, production date, and markings that the product was made with composite wood products that comply with applicable emission standards.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive and technical data and illustrations, clearly marked to show specific products, materials, and compliance with specified requirements. Include manufacturer's printed installation instructions.

B. Shop Drawings:

1. Submit Shop Drawings showing layouts, elevations, profiles, sections, and sizes; materials; finishes; details of fabrication; wood grain directions, ~~locations of all seams and joints in plastic laminate and transparent finished surfaces;~~ details of installation; and types of exposed fasteners. ~~Show sizes and locations of other Work to be mounted within or on finish carpentry Work, both in the shop and at the Site. Conform to requirements of the AWS Manual, Section 1.~~

- ~~1. Include engineering calculations, diagrams, and drawings sufficient to show compliance with specified seismic fabrication and attachment criteria. Calculations, diagrams, and drawings shall be stamped and signed by the qualified engineer specified hereinbefore. Submit engineering calculations at same time as Shop Drawings. Review of calculations and Shop Drawings will not relieve the Contractor of responsibility for providing attachment systems of the required strengths.~~
- ~~2. If Fabricator-Installer is a WI Licensee, the first page of Shop Drawings shall bear a WI "Certified Compliance Label". If Fabricator-Installer is not a WI Licensee, the first page of Shop Drawings and each finish carpentry elevation shall bear a WI "Certified Compliance Label".~~

C. Samples:

1. Wood Trim: Submit not less than four samples of each species and cut of wood to be furnished, not less than 6-inches by 12-inches in size. Submit additional samples for the preparation of finish samples as required by SECTION 09 91 00 "PAINTING".
2. Laminated Wood: Submit **24**12-inch long sample of laminated wood bench with specified finish; showing ~~band end condition~~ **eased edges and ends and one radius corner**.
3. **Sample WPP-3 Panels:** Submit 12-inch by 12-inch size samples of plastic laminate-covered composite core panels with selected plastic laminate on faces and edges and specified hardwood cap with specified finish.
- ~~3. Upholstery Fabric Samples: Submit 36-inch square samples of each type of upholstery fabric.~~
- ~~4. Built-in Seating Cushion: Submit full-size sample of fabricated seat cushion. Accepted sample will be returned to the Contractor and may be incorporated into the Work.~~

~~D. Fabricator-Installer's Qualification Data:~~

- ~~1. Submit evidence that fabricator-installer complies with specified qualification requirements. Include a list of completed jobs showing the job name and address; type of work; AWS Manual, AWI "Architectural Woodwork Quality Standards", or WI "Manual of Woodwork" quality grades met; date completed; and the names, addresses, and telephone numbers of the owner and architect of record for each.~~
- ~~2. If fabricator-installer is Licensee of the WI, submit evidence of such license.~~

~~E. Test Reports: Submit test reports from qualified independent Testing Agency showing compliance with specified fire test response characteristics.~~

F.D. Material Certifications:

1. Composite Wood Products: Prior to fabrication, submit manufacturer's Certificate of Compliance stating that formaldehyde emissions of composite wood products comply with specified requirements.

~~G. Fabrication and Installation Certifications.~~

- ~~1. If Fabricator-Installer is a WI Licensee, submit a WI "Certified Compliance Certificate" indicating that the products to be furnished and installed under this SECTION will meet all requirements of the AWS Manual grades specified and requirements of the Contract Documents.~~
- ~~2. If Fabricator-Installer is not a WI Licensee, submit a WI "Certified Compliance Tracking Acknowledgment" and evidence that the Fabricator-Installer has arranged for inspection of the finish carpentry Work by a WI Inspector after completion of fabrication and installation. If all conditions are found to be compliant, the WI inspector shall issue a "Certified Compliance Certificate" indicating that the products furnished for this Project fully meet all requirements of the AWS Manual quality grades specified.~~
- ~~3. After installation, if all conditions are found to be compliant, submit WI inspector's "Certified Compliance Certificate" indicating that the products installed for this Project fully meet all requirements of the AWS Manual quality grades specified.~~

H.E. Maintenance Data: Furnish finish materials manufacturers' printed recommendations for the care, cleaning, and maintenance of their respective products to the Owner.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver products suitably wrapped or packaged to protect against damage during shipping, storage, and handling. Do not remove protective coverings until time of installation.
- B. Do not deliver products until the building is fully enclosed, finish painting and other wet Work is completed and dry, overhead Work is complete, and the mechanical HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- C. Store products indoors, in a clean and dry location, out of the way of construction activities. Cover with suitable protective covering to keep products clean and to allow air circulation. Protect products from abnormal heat, extreme dryness, humid conditions, sudden changes in temperature, and direct sunlight.
- D. Acclimate products in installation areas as required prior to installation.
- E. Handle finish carpentry units in a manner so as not to damage surfaces or subject the units to stress.
- F. Comply with additional instructions and recommendations of product manufacturers, fabricator-installer, and AWS Manual.

1.05 COORDINATION

- A. Coordinate Work of other SECTIONS affecting finish carpentry, including but not limited to, backing requirements for support and attachment of finish carpentry Work; and mechanical, electrical, and plumbing Work occurring within or adjacent to this Work.
- B. Obtain accurate field measurements prior to preparation of Shop Drawings and fabrication, and show on the final Shop Drawings.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. General Requirements: Materials shall comply with the requirements of the applicable portions of the AWS Manual and shall be of the same quality grade as the quality grades of Work specified, except as otherwise specified herein.
- B. Solid Wood:
1. Exposed, to Receive Transparent Finish: Match veneer specified in SECTION 08 14 16 "FLUSH WOOD DOORS".
 2. Concealed: Fabricator-Installer's option, in compliance with the specified AWS Manual quality grade applicable to the Work.
 3. Laminated Wood: Laminated edge grain hard maple (*Acer Saccharum*) NHLA First Grade with knots, holes, and other blemishes culled out, waterproof glue, 1-1/4 inches thick, 1-inch radius corners. Stagger joints between individual laminated members less than full-bench length.
- C. Steel Shapes: As specified in SECTION 05 50 00 "METAL FABRICATIONS".
- ~~D. Built-in Seating Materials:~~
- ~~1. Upholstery Fabric: Manufacturer, product, and color as noted in SECTION 09 00 00 "FINISHES".~~
 - ~~2. Medium Density Foam for Built-in Seating Cushions: Premium grade expanded urethane rubber foam, slab or molded, with the following characteristics when tested in compliance with ASTM D3574. Foam shall have an expected life expectancy of 12 to 18 years under normal use and shall maintain its original shape and density during the expected lifetime.~~
 - ~~a. Density: Not less than 2.8 pcf.~~
 - ~~b. Indentation Force Deflection (IFD): Not less than 35 pounds.~~
 - ~~c. Compression: 35 to 40 percent.~~
 - ~~3. Non-Slip Pad: Eastex Products, Inc. "Slip-Not Grip Fabric SN12000D" knit polyester, or accepted equal.~~
- D. Fire Retardant Composite Core: Sierra Pine "Meditate FR" flame-retardant medium density fiberboard meeting ANSI A208.2 Grade 115 and regulatory requirements, fabricated with formaldehyde free adhesive system, 5/8-inch thick, or accepted equal.
- E. Plastic Laminate: UL-listed fire-retardant type as As specified in SECTION 06 41 16 "PLASTIC LAMINATE-CLAD ARCHITECTURAL CABINETS" except plastic laminate manufacturer, color, and finish will be selected by the Architect.
- F. Laminated Bench Pedestals: Heavy-duty bench pedestal consisting of a cast iron base and cast-iron top flange with heavy-duty steel pipe or tube support securely attached to base and flange. Base shall be designed to be secured to concrete floor with concealed expansion bolts. Finish pedestals with factory-applied thermoset powdercoat finish in custom color as indicated.

- G. Field-Applied Touch-up Materials: In compliance with regulatory requirements, compatible with shop-applied finishes, as recommended in writing the applicable manufacturer.
- H. Anchors and Fasteners:
1. General Requirements:
 - a. Provide anchors and fasteners as required for complete fabrication and installation of finish carpentry Work.
 - b. Provide types and sizes best-suited for the intended purpose, as selected by the fabricator-installer, and sized for adequate support of materials being fastened.
 - c. Include wood and sheet metal screws, bolts, toggle bolts, lag screws, expansion shields, finish washers, concealed clamps, and similar items.
 - d. Anchors and fasteners shall be zinc-electroplated for corrosion resistance to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5.
 - e. Furnish fasteners with countersunk heads where a smooth backing surface is required.
 2. Bolts: Steel machine bolts in compliance with ASTM A307, Grade A with hexagonal nuts in compliance with ASTM A563, Grade A and flat washers in compliance with ANSI B27.2 or B27.4.
 3. Steel Lag Bolts: In compliance with ASME B18.2.1.
 4. Toggle Bolts: in compliance with FS FF-B-588, Type I (spring-wing), Class A (sheet metal winds), Style 2 (continuous thread stud).
 5. Expansion Anchors: Hilti, Inc. "Kwik Bolt TZ" fabricated of plated carbon steel, or accepted equal.
 6. Wood Screws: In compliance with ASME B18.6.1.
 7. Nails, Brads, and Staples: In compliance with ASTM F1667.
 8. Lock Washers: Helical spring type in compliance with ANSI B18.21.1, of material to match bolts. Furnish where bolts are subject to loosening.
- J.I. Other Materials: In compliance with applicable portions of the AWS Manual, as proposed and accepted.

2.02 SHOP FABRICATION

A. General Requirements

1. Fabricate Work in compliance with the accepted Shop Drawings, applicable portions of the AWS Manual for the quality grade specified, manufacturer's printed instructions and recommendations, as indicated, and as specified.
2. Insofar as practicable make cuts as required to accommodate the Work of other SECTIONS.

- ~~3. Fabricate fillers and scribe strips of same materials and finishes as items with which they are associated.~~
- 4.3. Accurately machine all parts chip-free; completely assemble components by expert cabinetmakers to assure proper fit and finish.
- ~~5. Reinforce joints subject to strain, using screws and bolts to assure their retaining tight. At edge-to-edge joined solid wood, use matched tongues and grooves or wood splines, reinforced with dowels if necessary. Glue joints under pressure.~~
- 6.4. Machine or hand sand exposed and semi-exposed surfaces. Make sharp arises slightly rounded, but keep external and internal angles true to detail. Completely remove tool marks, raised grain and other causes of unevenness or lack of smoothness.

~~B. Built-in Seating:~~

- ~~1. Fabricate built-in seating in whole units to dimensions, profiles, shapes, and details indicated.~~
- ~~2. Fabricate back and seating cushions with foam, upholstery fabric, and Dacron wrap. Include full-width heavy-duty zipper under upholstery flap for inserting and removing foam. Provide non-slip pad sewn into the bottom of seating cushions.~~
- ~~3. Fabricate plastic laminate covered surfaces of balanced construction. At edges, provide square self-edged plastic laminate matching adjacent surface.~~
- ~~4. Provide 1-inch radius on exposed corners of exposed surfaces.~~
- ~~5. Provide means to access concealed fasteners for subsequent removal and replacement of worn cushions without requiring disassembly of supporting bench.~~
- ~~6. Fabricate steel supports as specified in SECTION 05 50 00 "METAL FABRICATIONS".~~
- ~~7. Provide finish panels at exposed ends.~~

~~C.B.~~ Laminated Wood Benches:

1. Fabricate laminated wood benches in single lengths to dimensions, profiles, shapes, and details indicated. Provide 1-inch radius on exposed corners. Ease all edges and ends.
2. Sand smooth and shop finish with vinyl sealer and two coats of transparent, satin-finish catalyzed polyurethane in compliance with AWS Manual System 11. Lightly sand sealer and first finish coat and clean free of dust and other foreign materials prior to application of subsequent finish coats.

~~D.C.~~ Miscellaneous Millwork and Trim:

1. Fabricate members of fire-retardant treated hardwood to dimensions, profiles, shapes, and details indicated.
2. Fabricate in as long units as practicable to minimize field cutting and joining. Where necessary to cut and fit at the Site provide materials with ample allowance for cutting and fitting.

3. Rout or groove backs of flat members as required for accurate fit; kerf backs of other wide flat members except plywood or veneered members.
4. Distribute defects allowed in quality grade specified to best overall visual advantage.

2.03 FIRE-RETARDANT TREATMENT

- A. Fire-retardant treat wood and plywood used for permanent part of the Work. Size before treatment to minimize cutting after treatment. Brush coat surfaces cut after treatment using same formulation impregnated at plant. No ripping of wood will be permitted after treatment.
- B. Materials for Interior Fire-retardant Treatment: Hoover Treated Wood Products, Inc. "Pyro-Guard", Hickson Corp. "Dricon FRT", or accepted equal. "Pyro-Guard" is specified to set a standard. Fire-retardant formulation shall be free of halogens, sulfates, chlorides, and ammonium phosphate.
- C. Treatment:
 1. Use pressure process with a paintable water-soluble fire-retardant formulation.
 2. Fire-retardant treated lumber and plywood shall use design value adjustments and span ratings published in National Evaluation Report 457, issued by the National Evaluation Service, Inc.
 3. Fire-retardant treated lumber shall have an equilibrium moisture content of not over 28 percent when tested in accordance with ASTM D3201 at 92 percent humidity.
 4. After treatment, kiln dry fire-retardant treated wood and plywood to a moisture content of 19 percent for lumber and 15 percent for plywood. Kiln drying after treatment shall be monitored by Timber Products Inspection, and so indicated on each piece of wood and plywood.
- D. Identification: Deliver each piece of wood with UL paper label attached intact and indicating fire hazard classification.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify that conditions and surfaces to receive finish carpentry are satisfactory.
- B. Do not begin installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection:
 1. Protect adjacent surfaces and finishes from damage during handling and installation of finish carpentry.
 2. Protect products and fabrications from damage during field handling and installation.

B. Preparation:

1. Remove products from their protective wrappings as near the area of installation as possible.
2. Allow materials and products to acclimate to jobsite conditions in compliance with requirements of the AWS Manual and recommendations of applicable manufacturer.

3.03 BLOCKING, FURRING AND NAILERS

- A. Provide solid wood blocking, furring, and nailers as indicated and where necessary to obtain required lines and levels in finished surface and to provide solid nailing under edges and joints.
- B. Fit closely and accurately; use wood shims wherever necessary to form adequate fasteners.
- C. Secure to concrete with expansion bolts, unless otherwise indicated. Secure to metal framing with sheet metal screws, unless otherwise indicated.

3.04 INSTALLATION

A. General Requirements

1. Install finish carpentry Work in compliance with the requirements of the AWS Manual, accepted Shop Drawings, manufacturers' printed instructions, as indicated, and as specified.
2. Set Work straight, plumb, and level, with tight joints between sections or units; scribe to wall and other surfaces as required.
3. Wherever possible install Work with concealed fasteners. Install without splitting materials; pre-drill as required. Completely fill or putty holes; leave smooth and flush with adjacent surfaces.

~~B. Built-in Seating:~~

- ~~1. Secure seating units to structural backing with concealed fasteners to resist both gravity and seismic forces in compliance with the regulatory requirements.~~
- ~~3. Provide fillers and scribe strips of same materials and finishes. Cut scribe strips so that no gap greater than 1/16 inch exists where seating is fitted against flat or irregular surfaces.~~
- ~~4. Install seating units so they will lie in one plane without gaps between sections.~~
- ~~5. Install cushions just prior to inspection for Substantial Completion and securely fasten in place to prevent movement.~~

B. Plastic Laminate-Covered Composite Core Wall Protection Panels (WPP-2):

1. Securely fasten composite core panels to wall framing and blocking materials with countersunk fasteners.

2. Adhere plastic laminate to faces, bottom edges, and exposed vertical edges of panels. Scribe face laminate to adjoining surfaces at internal vertical corners and seal with slight beads of continuous beads of sealant. Provide self-edging at external edges.
3. Provide nominal 5/4 x 5/4 continuous hardwood cap, rabbeted to lap plastic laminate 1/4-inch, as specified hereinafter.

C. Laminated Wood Benches:

1. Locate pedestals not more than 12-inches from ends of bench tops and uniformly spaced not more than 48-inches in between. Install pedestals plumb and securely anchor to concrete floor using suitable anchors and fasteners.
2. Install bench tops level and securely fasten to pedestals with concealed lag bolts.

D. Miscellaneous Millwork and Wood Trim:

1. Set and secure materials and components in place plumb and level.
2. Scribe work abutting other surfaces, materials, and components.
3. Make tight connections between members. Joints shall be smooth, flush, and hairline tight.
4. Scarf cut running joints. Cope trim at returns and miter-cut at corners. Produce joints with full surface contact throughout length of joint.
5. Securely attach trim to surrounding construction with concealed fasteners wherever possible. Where exposed fasteners are necessary, countersink fine finishing nails in uniform pattern without splitting wood and apply wood filler matching color of adjacent wood in fastener indentations.
6. Field-applied finishes are specified in SECTION 09 91 00 "PAINTING".

3.05 CLEANING AND REPAIRS

- A. Following completion of installation, remove dirt and other adhering foreign matter from installed materials.
- B. Clean items of finish carpentry in compliance with manufacturers' printed instructions and recommendations.
- C. Remove materials damaged beyond acceptable repair or stained beyond cleaning and provide new acceptable Work at no increase in Contract Time and at no additional cost to the Owner.

3.06 COMPLETION

- A. When complete, finish carpentry Work shall be plumb and level, securely attached to supporting Work, clean, and free from structural defects, distortions, open joints, marks, nicks, scratches, stains, and other defects and damage.
- B. Finishes shall match samples accepted by the Architect.
- C. Joints in panels and trim shall be smooth, flush and free from offsets and gaps.

3.07 PROTECTION

- A. Protect finish carpentry from damage and deterioration until time of completion and acceptance by the Owner. Remove protective coverings before inspection for Substantial Completion.
- B. Do not use ~~seats, benches or other finish carpentry~~ for storage or as a working surface.
- C. Do not allow finish carpentry Work to be exposed to construction activity and traffic without adequate protection.
- D. Maintain temperature and humidity conditions required to protect the Work.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This SECTION describes the requirements for furnishing and applying joint sealants and associated materials.
- B. The full extent of joint sealant Work is not necessarily fully or individually specified herein or indicated. Provide sealants wherever required to prevent light leakage as well as moisture leakage, at exposed joints around plumbing fixtures, casework, door and window frames, and at other locations as required to facilitate cleaning and sanitation. Sealants shall not stain or deteriorate joint substrates or adjacent Work. Consult the Architect if in doubt as to whether sealant is required at a given location.

1.02 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer of Exterior Weatherproofing Sealants: Manufacturer of exterior waterproofing joint sealants shall have been continuously engaged in manufacturing sealants of the types required for not less than ten (10) years prior to the date of this Project.
 - 2. Manufacturer of Other Joint Sealants: Manufacturer of joint sealants other than exterior waterproofing sealants shall have been continuously engaged in manufacturing sealants of the types required for not less than five (5) years prior to the date of this Project.
 - 3. Applicator: Applicator shall specialize in the application of joint sealants and shall have not less than five (5) years continuous experience.
- B. Sealant Manufacturers' Requirements:
 - 1. Sealant manufacturer shall furnish the services of an experienced technical services representative who is knowledgeable and experienced in the application of specified products and has authority to make binding decisions on behalf of the manufacturer. An independent sales representative or manufacturer's representative not authorized to make such decisions is not acceptable. Manufacturer's representative shall be available to meet and consult with the Owner, Architect, Contractor, and applicator at the Site during the course of this Work and provide field services as specified in Part 3.
 - 2. Sealant manufacturer shall confirm in writing that all materials contacting the sealants, including joint backings, gaskets, spacers, and joint substrates, are compatible and non-staining with the sealant to be applied.
 - 3. Sealant manufacturer shall confirm in writing that appropriate joint preparation and priming techniques have been performed, as required for rapid, acceptable adhesion of sealants to substrates, and that substrates are acceptable.

C. Regulatory Requirements:

1. Materials and application shall be in compliance with requirements of the applicable building code and other regulations. Refer to SECTION 01 41 00 "REGULATORY REQUIREMENTS" for further information.
2. Silicone for use in fire-resistant assemblies shall be tested in accordance with ASTM E119 or UL 263.

D. Pre-Application Meeting:

1. Schedule and conduct an on-Site meeting to review each type of specified exterior joint sealant Work prior to beginning application.
2. Attending shall be representatives of the Owner, Contractor, Architect, Testing Laboratory, sealant manufacturer, applicator, and others whose Work may affect, or be affected by, the quality of the joint sealant Work.
3. Review in detail:
 - a. Manufacturer's requirements, Specifications, application instructions, areas to receive Work, details, and other related Work.
 - b. Job conditions, environmental requirements, schedule, construction sequence, coordination with other Work, requirements for application and quality of completed Work, and protection of adjacent Work and property.
 - c. Proper waste management and protection of the environment.
 - d. Protection of the completed Work during the remainder of the construction period.
4. Review and resolve anticipated and discovered conflicts, incompatibilities, and inadequacies at the meeting.
5. Comply with additional requirements specified in SECTION 01 31 00 "PROJECT MANAGEMENT AND COORDINATION".

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's printed descriptive information, technical data, and specifications for sealants, backing, and associated materials, clearly marked to show specific product types, variations, and materials involved. Include substantiating test data, reports, and manufacturer's printed application instructions.
- B. Samples:
1. Prior to ordering materials or beginning application, submit samples of actual sealants showing the standard colors available for each sealant material intended for application in an exposed location.
 2. Prior to ordering materials or beginning application, submit samples of actual custom-color sealants. Resubmit until acceptable colors are achieved.

3. Materials applied prior to the Architect's selection of color will be subject to removal and replacement with an acceptable material at Contractor's expense.
- C. Certifications:
1. Submit sealant manufacturers' written certifications that all materials contacting the sealants, including joint backings, gaskets, spacers, and joint substrates, are compatible and non-staining with the sealant to be applied.
 2. Submit sealant manufacturers' written certifications that appropriate joint preparation and priming techniques have been performed, as required for rapid, acceptable adhesion of sealants to substrates, and that substrates are acceptable.
 3. Submit sealant manufacturer's written certification or test results of compatibility and adhesion properties of sealants and adjacent materials to be used on Project.
- D. Field Test Reports: Submit test reports for field tests specified in Part 3.
- E. Warranty: Submit review copy of manufacturer's warranty for exterior weatherproofing sealants.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in manufacturer's unopened original protective packaging with manufacturer's name, label, and product identification clearly visible and lot numbers where appropriate.
- B. Do not deliver materials whose shelf life has expired.
- C. Store products inside enclosed storage facilities or enclosed building in a clean, dry, secure location, protected from construction activities, until ready for use in the Work. Maintain storage spaces and products within temperature and humidity ranges recommended by the manufacturer.
- D. Comply with additional requirements of the manufacturer.

1.06 JOB CONDITIONS

- A. Do not apply sealants during rainfall or windy conditions, unless protection from windborne contaminants can be ensured.
- B. Apply sealants within temperature and humidity ranges recommended in writing by the applicable sealant manufacturer.

1.07 COORDINATION

- A. Schedule sufficient time to allow manufacturer's representative to test substrates and adjacent materials for compatibility with sealants.

1.08 WARRANTY - EXTERIOR WEATHERPROOFING SEALANTS

- A. For all weatherproofing applications furnish to the Owner a written warranty, executed by the manufacturer, in which the manufacturer agrees to replace joint sealants that fail to achieve an airtight or watertight seal or that exhibit loss of adhesion, cohesion, or color stability during the warranty period.

- B. Warranty period shall be twenty (20) years commencing on the date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General Requirements:

1. Stain-Test-Response Characteristics: Where sealants are specified to be non-staining, provide products that have undergone testing according to ASTM C1248 and have not stained porous joint substrates indicated for Project.
2. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Joint Sealants for Exterior Weatherproofing Use:

1. Sealant for General Exterior Building Use, Except as Otherwise Specified: In compliance with ASTM C920, Type S, Grade NS, Class 25, Use NT, M, G, A & O, single-component, low-modulus, high-performance, silicone sealant; GE Silicones "SilPruf SCS2000" (VOC 20 g/L), Dow Corning Corp. "795 Silicone Building Sealant" (VOC 28 g/L) or "791 Silicone Perimeter Sealant" (VOC 46 g/L), or accepted equal.
 - a. Sealant color shall be custom to match Architect's sample.

C. Joint Sealants for Interior Use:

1. General Use: Single-component, gun-grade, paintable, acrylic-latex, water-base sealant in compliance with ASTM C920, Type S, Grade NS, Class 25;; Bostik Inc. "Chem-Calk 600" (VOC 33 g/L), Pecora Corp. "AC20" (VOC 31 g/L), Tremco Inc. "Tremflex 834" (VOC 22 g/L), or accepted equal.
2. Sanitary Sealing: Single-component, silicone rubber in compliance with ASTM C920, Type S, Grade NS, Class25; primerless, flexible, and mildew-resistant; Dow Corning Corp. "786 Mildew Resistant Silicone Sealant" (VOC 33 g/L), or accepted equal.
 - a. Sealant color shall be white.
3. Acoustical Sealing: In compliance with ASTM C834, permanently plastic, non-bleeding, non-staining, paintable, synthetic polymer base sealant; United States Gypsum "Sheetrock Brand Acoustical Sealant" (VOC 65 g/L), Pecora Corp. "AIS-919" VOC 31 g/L, Titebond "Greenchoice Acoustical Sound Sealant" (VOC 42 g/L), or accepted equal.
4. Joints in Plastic Laminate: Dow Corning "795 Silicone Building Sealant" (VOC 28 g/L), non-sagging, in colors as selected by the Architect from the manufacturer's full range of standards.

D. Associated Materials:

1. General: Requirements: Provide types as recommended by applicable sealant manufacturer to suit Project conditions.
2. Backer Rod:
 - a. Round, closed cell foam, non-staining, resilient material such as neoprene, butyl, polyethylene, or open cell polyurethane, compatible with sealant to be used. Use neoprene or butyl for paving sealant backing.
 - b. Rod shall be sized and shaped to control depth of sealant and to provide 20 to 50 percent compression upon insertion.
3. Joint Cleaner: VOC compliant, non-corrosive and non-staining type comparable with joint forming materials, as recommended in writing by sealant manufacturer to suit application.
4. Primer: Non-corrosive, non-staining type.
5. Masking Tape: Non-staining, non-absorbent pressure-sensitive adhesive paper type.
6. Bond Breaker: Pressure-sensitive adhesive polyethylene tape.
7. Drain Tubes: Type resistant to exposure to ozone and ultraviolet radiation for life of sealant, size appropriate to joint with 1/4-inch minimum inside diameter, as recommended by sealant manufacturer.

- E. Colors of Non-Exposed Sealants and Sealants to be Painted: Wherever sealants are not exposed to view or are specified to be painted, provide manufacturer's standard color that has the best overall performance characteristics for the application noted.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Together with applicable manufacturer and applicator, inspect joints to be sealed to determine if conditions are satisfactory for the proper application of joint sealants and associated materials.
- B. If unsatisfactory conditions exist, submit written report of detrimental conditions. Do not begin Work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. General Requirements: Comply with manufacturer's printed instructions and recommendations, requirements of ASTM C1193, and as specified.
- B. Cleaning: Clean joint surfaces, using joint cleaner as necessary, of dust, dirt, oil, grease, rust, lacquers, laitance, release agents, moisture, water repellents, and other matter that might adversely affect adhesion of sealants. Do not damage adjoining Work.
- C. Masking: Mask areas adjacent to joints.

- D. Priming: Apply primer as required.
- E. Drain Tubes: Clean tubes of materials that may inhibit sealant adhesion. Install tubes where required to drain moisture through sealant joint from horizontal legs of flashing assemblies and where indicated, evenly spaced no further than 24-inches on center. Provide not less than 1/8 inch of sealant between tube and adjacent materials.
- F. Joints shall enclose sealant on three sides.
 - 1. Where adequate joints for sealants have not been provided, suitable joints shall be cleaned out to the depth required, or as indicated, and ground to a minimum width of 1/4-inch without damage to the adjoining Work, unless otherwise specified or indicated.
 - 2. No grinding shall be performed on metal surfaces.

3.03 FIELD TESTING - EXTERIOR SILICONE SEALANTS

- A. Perform field tests for adhesion and compatibility with silicone sealant and all materials to be in contact with sealants in compliance with the manufacturer's recommended test procedures.
- B. Submit specified certification prior to beginning application.

3.04 APPLICATION

- A. General Requirements:
 - 1. Apply sealants and associated materials in compliance with manufacturer's printed instructions and recommendations, ASTM C1193, as indicated, and as specified.
 - 2. Do not apply materials whose shelf life has expired.
 - 3. Apply sealant with width-to-depth ratios as recommended by the sealant manufacturer.
 - 4. Apply sealants in joints using pressure gun with nozzle cut to fit joint width.
 - 5. Place sealants in uniform, continuous beads without gaps or air pockets.
 - 6. Tool joints to concave configuration within 10 minutes of sealant applications before skinning or curing begins.
 - 7. If masking materials are used, remove immediately after tooling without disturbing sealant.
 - 8. Seal joints adjacent to painted Work before the final coat of paint is applied.
 - 9. Allow joints to cure undisturbed in accordance with the manufacturer's printed recommendations.
- B. Backing Materials: Install backing materials in joints using blunt instrument to avoid puncturing; do not twist backing while installing. Install backing so that joint depth is 50 percent of joint width, but a minimum of 1/4-inch deep.

- C. Bond Breakers: Provide bond breakers as recommended by the sealant manufacturer.
- D. Acoustical Sealant:
 - 1. Non-Gypsum Board Sound-Rated Construction:
 - a. Provide continuous beads of acoustical sealant to close off sound-flanking paths around and through the Work except as required by SECTION 07 84 00 "FIRESTOPPING" for fire-rated construction.
 - b. At sound-rated construction and elsewhere as indicated, prepare surfaces and apply acoustical sealant in compliance with referenced acoustical standards, ASTM C919, and as specified.
 - c. Seal construction at perimeters, behind control joints, and at openings and penetrations with continuous beads of acoustical sealant.
 - d. Apply acoustical sealant at both faces of partitions at perimeters.
 - e. Seal penetrations through walls, or cuts in one face of walls, with a full bead of sealant at perimeter and at electrical and service boxes, valve boxes, conduits, pipes, ducts, and similar items.
 - 2. Sound-Rated Gypsum Board Construction: Specified in SECTION 09 29 00 "GYPSUM BOARD".

3.05 CLEANING AND REPAIRS

- A. Cleaning:
 - 1. Remove spilled and excess materials adjacent to joints without damaging adjacent surfaces.
 - 2. Leave finished Work in neat, clean condition with no evidence of spillovers or damage to adjacent surfaces.
- B. Repairs: Remove damaged and deteriorated sealants and provide new acceptable sealants matching adjacent Work at no additional cost to the Owner.

3.06 COMPLETION

- A. When complete, applied joint sealants shall be continuous, waterproof, airtight, and free from air pockets and other voids. Sealants shall completely fill recesses in each joint configuration and shall be in full contact and adhesion with sides of joint.
- B. Sealants shall be free of foreign embedded matter and colors shall match accepted samples.

3.07 PROTECTION

- A. Protect joint sealants, during and after curing period, so joint sealant will be free from embedded foreign material and other damage and deterioration at the time of completion and acceptance by the Owner.

END OF SECTION

SECTION 08 80 00

GLAZING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This SECTION describes the requirements for the materials and installation of glazing.
- B. Metal-framed mirrors are specified in SECTION 10 28 10 "TOILET, BATH, AND JANITORIAL ACCESSORIES".

1.02 DEFINITIONS

- A. Deterioration:
 - 1. Ballistics-Rated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning glazing contrary to manufacturer's printed instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced standard.
 - 2. Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's printed instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.
 - 3. Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's printed instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
- B. Insulating Glass: Hermetically sealed glazing units consisting of combinations of two or more lites of glass separated by a dry interspace.
- C. Interspace: Space between lites of an insulating glass unit that contains dehydrated air or a specified gas.
- D. Light to Solar Gain (LSG): Ratio determined by Visible Light Transmittance divided by Solar Heat Gain Coefficient.
- E. Shading Coefficient: Ratio of solar heat gain through the glazing relative to 1/8-inch thick clear glass under the same design conditions.

1.03 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of exterior and interior glazing through one source from a single manufacturer.

B. Qualifications:

1. Manufacturer: Manufacturer shall have been continuously engaged in manufacturing glass products of the types specified for not less than ten (10) years prior to the date of this Project and able to furnish products without delay. Manufacturer may be a firm that produces primary glass, fabricated glass, or both, as defined in referenced glazing publications.
2. Installer: Installer shall be experienced in installing glazing similar in material, design, and extent to that specified for this Project and shall be able to show prior completed jobs that have resulted in glass installations with a record of successful in-service performance. Glazers shall be certified under the National Glass Association's Certified Glass Installer Program.

~~C. Preconstruction Mirror Mastic Glass Coating Compatibility Test: Submit mirror mastic products to organic protective coating manufacturer for testing to determine compatibility of adhesive with mirror coating. Do not proceed with installation until testing has determined that materials are compatible. Submit written report of test results upon request.~~

D.C. Regulatory Requirements:

1. General: Materials and installation shall be in compliance with requirements of the applicable building code and other regulations. Refer to SECTION 01 41 00 "REGULATORY REQUIREMENTS" for further information.
2. Impact Safety Glazing:
 - a. Impact safety glazing and its installation shall comply with CPSC 16 CFR Part 1201 and ANSI Z97.1. Where glazing units, including Kind FT glass and laminated glass, are specified for glazing lites more than 9 square feet in exposed surface area of one side, provide glazing products that comply with Category II materials; for lites 9 square feet or less in exposed surface area of one side, provide glazing products that comply with Category I or II materials except for hazardous locations where Category II materials are required by 16 CFR 1201 and regulations of authorities having jurisdiction.
 - b. Each lite of safety glazing material shall be identified by a permanent label that specifies the labeler, whether manufacturer or installer; and designation of the applicable safety glazing standard in compliance with requirements of the applicable building code. Label shall be etched or ceramic fired on the glass and readable from the inside of the building after installation. Locate label in lower corner of glass.
 - c. Tempered spandrel glass is exempted from permanent labeling but such glass shall be identified by the manufacturer with a removable paper label.
3. Interior Fire-Protection-Rated Glazing:
 - a. Fire-protection-rated glazing shall be tested in accordance with and meet the acceptance criteria of NFPA 252 "Fire Tests of Door Assemblies" and NFPA 257 "Fire Tests of Window Assemblies" under positive pressure, as applicable to the Work, shall comply with NFPA 80 "Fire Doors and Other Opening Protectives", and shall be listed and labeled by UL for fire ratings scheduled in compliance with applicable building code requirements.

- b. Each lite of fire-protection-rated glazing shall be identified by a permanent label showing the name of the manufacturer, test standard, and other information required by the applicable building code. Label shall be etched or ceramic fired on the glass and readable from the inside of the building after installation. Locate label in lower corner of glass.

4. Exterior Fire-Protection-Rated Glazing:

- a. Fire-protection-rated glazing shall be tested in accordance with ASTM E119 and UL 263 and shall be listed and labeled by UL for fire ratings indicated on the Drawings.
- b. Each lite of fire-protection-rated glazing shall be identified by a permanent label showing the name of the manufacturer, test standard, control number, fire rating, and other information required by the applicable building code. Label shall be etched or ceramic fired on the glass and readable from the inside of the building after installation. Locate label in lower corner of glass.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's printed technical data for each glazing material and fabricated glass product required. Include manufacturer's and fabricator's printed installation instructions.
- B. Manufacturer's Analysis: Submit glass manufacturer's written analysis of glazing thicknesses and glazing design.
- C. Certifications: Submit manufacturers' and fabricators' written certifications that products meet or exceed specified requirements and have been constructed to conform to design, materials, and construction equivalent to requirements for labeled assemblies and are suitable for the application indicated. Separate certifications are not required for glazing materials bearing manufacturer's permanent labels designating type and thickness of glass, provided labels represent a quality control program of a recognized certification agency or independent testing agency acceptable to authorities having jurisdiction.
- D. Samples: Submit one 12-inch square sample of each glass type specified. ~~For mirrors, include required edge treatment on two adjoining edges.~~
- E. Maintenance Data: Furnish manufacturer's written instructions for the care, maintenance, and cleaning of each type of glass and mirror to the Owner.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle glass with manufacturer's labels intact. Do not remove labels until time of final cleaning except as specified in Article titled "Cleaning" in Part 3 of this SECTION.
- B. Deliver and store sealant in manufacturer's unopened original protective packaging with manufacturer's name, label, and product identification and unexpired use before date clearly visible, and lot numbers where appropriate. Do not deliver or use materials whose shelf life has expired. Store materials under conditions recommended by the manufacturer.
- C. Keep glass free from contamination by materials capable of staining and otherwise damaging glass.

~~D. Store mirrors indoors, protected from moisture including condensation. Comply with recommendations of the mirror manufacturer and the Mirror Division of GANA to prevent deterioration of silvering, damage to edges, abrasion of glass surfaces and applied coatings, and other damage. Quality designation and guarantee label shall be affixed to each mirror, or submit manufacturer's certification that mirrors meet Contract requirements.~~

~~E. Quality designation and guarantee label shall be affixed to each mirror, or submit manufacturer's certification that mirrors meet Contract requirements.~~

~~F.~~**D.** Comply with additional requirements and precautions of GANA, manufacturer, and fabricator.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Perform glazing on dry surfaces only.

B. Apply sealants within temperature range recommended by manufacturer.

~~C. Do not install mirrors until ambient temperature and humidity conditions are maintained at levels required for final occupancy.~~

1.07 WARRANTIES

A. General Requirements: Furnish manufacturers' written, non-prorated warranties as follows to the Owner. During warranty period, remove defective glazing units and provide new acceptable units at no additional cost to the Owner.

B. Insulating Units: Warrant insulating glass units set in vertical position to be free from defects in materials and workmanship. Remove glazing units that deteriorate, as defined in Article titled "Definitions", during the warranty period and provide new acceptable Work. Warranty period shall be ten (10) years from date permanently imprinted on unit but not less than nine (9) years from the date of Substantial Completion.

C. Glass with Low-E and Ceramic Coatings: Warrant glass with low-emissivity and ceramic coatings to be free from defects in materials and workmanship. Remove glazing units that deteriorate, as defined in Article titled "Definitions", during the warranty period and provide new acceptable Work. Warranty period shall be ten (10) years from date permanently imprinted on unit but not less than nine (9) years from the date of Substantial Completion.

D. Ballistics-Resistant Glazing: Warrant ballistics-resistant glazing to be free from defects in materials and workmanship. Warranty period shall be five (5) years from the date of Substantial Completion.

~~E. Mirrors:~~

~~1. Warrant mirrors to be free from defects in materials and workmanship in accordance with the specified mirror quality.~~

~~2. Deterioration of silvered mirrors shall include defects that develop from normal use that are attributable to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning mirrors contrary to mirror manufacturer's printed instructions. Defects include, but are not limited to, discoloration, black spots, clouding of the silver film and other silver spoilage.~~

~~3. Warranty period shall be ten (10) years from date of Substantial Completion.~~

PART 2 - PRODUCTS

2.01 ACCEPTABLE FABRICATORS - INSULATED GLASS UNITS

- A. Subject to compliance with specified requirements, furnish insulated glass units fabricated by one of the following: Oldcastle Glass, PPG, or Viracon.

2.02 GLASS, GENERAL

- A. Materials, as applicable, shall conform to ASTM C1036, ASTM C1048, ASTM C1172, ANSI Z97.1, and CPSC 16 CFR Part 1201 as applicable to the Work.
- B. Verify that glass thickness specified are appropriate for the applications indicated and meet applicable regulatory requirements. Minimum thickness for all types shall be as required by code and recommended by glass manufacturer for sizes, applications, and performance levels required, but not less than that specified. Provide the same thickness for each tint color required throughout the Work to ensure uniformity of color.
- C. For butt-glazed conditions, grind and polish edges of lites in a manner to produce square edges.

2.03 EXTERIOR GLASS TYPES

- A. GL-1 (Clear Insulating Glass):
 - 1. Overall Appearance: Neutral clear.
 - 2. Total Thickness: Not less than nominal 1-inch. Actual thickness may vary due to glass thickness tolerances.
 - 3. Composition:
 - a. Outer Lite: Clear float glass in compliance with ASTM C1036, Type I, Class 1, Quality q3, heat-strengthened in accordance with ASTM C1048 Kind HS as specified hereinafter in the Article titled "Heat Treatments", with metallic low-emissivity (low-e) coating vacuum deposited (sputtered) on the No. 2 glazing surface in compliance with ASTM C1376, meeting specified performance criteria, not less than nominal 1/4-inch thick. Subject to compliance with requirements, furnish one of the following:
 - 1) Viracon "Solarscreen 2000 - VE 1-2M".
 - 2) PPG "Solarban 60".
 - 3) Guardian Industries "SunGuard Super Neutral 68 Clear".
 - b. Interspace: 1/2-inch thick, hermetically sealed and dehydrated space with spacer bar and filled with dry air or argon gas to meet performance criteria.
 - c. Inner Lite: Clear float glass in compliance with ASTM C1036, Type I, Class 1, Quality q3, not less than 1/4-inch thick.

4. Performance Criteria:
 - a. Visible Light Transmittance: Not less than 68 percent.
 - b. ASHRAE Winter Nighttime U-Value: Not more than 0.29 Btu/hr/sf/deg F.
 - c. ASHRAE Summer Daytime U-Value: Not more than 0.28 Btu/hr/sf/deg F.
 - d. Shading Coefficient: Not more than 0.44.
 - e. Solar Gain Factor or Solar Heat Gain Coefficient (SHGC): Not more than 0.38.
 - f. Light to Solar Gain (LSG): Not less than 1.80.
- B. GL-2 (Clear Tempered Insulating Glass): As specified for GL-1 except both lites fully tempered in compliance with ASTM C1048 Kind FT.
- C. GL-3 (Insulating Tempered Spandrel Glass):
 1. Exterior Lite: As specified for outer lite of GL-1, except fully tempered in accordance with ASTM C1048 Kind HS as specified hereinafter in the Article titled "Heat Treatments".
 2. Interspace: 1/2-inch thick hermetically sealed and dehydrated space with spacer bar and filled with dry air or argon gas as required to meet performance criteria.
 3. Interior Lite: Tempered glass as specified for GL-B with Viracon "V933LS" warm gray, lead-free, ceramic opacifier on the No.3 glazing surface; not less than nominal 1/4-inch (6-mm) thick.
- D. GL-4 (Fire-Rated Insulating Glass): "Firelite IGU" as follows, or accepted equal:
 1. Overall Appearance: Neutral clear.
 2. Total Thickness: Not less than nominal 15/16-inch. Actual thickness may vary due to glass thickness tolerances.
 3. Composition:
 - a. Exterior Lite: As specified for outer lite of GL-1.
 - b. Interspace: 1/2-inch thick hermetically sealed and dehydrated space with spacer bar and filled with dry air or argon gas as required to meet performance criteria.
 - c. Interior Lite: Fire-rated Pilkington "Pyrostop 60" glazing, consisting of multiple sheets of "Optiwhite" glass laminated with intumescent interlayers, 1-1/16 inches thick. Product shall be UL listed and labeled as fire resistant for fire ratings indicated.

2.04 INTERIOR GLASS TYPES

- A. GL-A (Clear Float Glass): Clear float glass in compliance with ASTM C1036, Type I, Class 1, Quality q3, not less than nominal 1/4-inch thick.

- B. GL-B (Clear Tempered Safety Glass): Clear float glass as specified for GL-A, fully tempered as specified in Article titled "Heat Treatments", not less than nominal 1/4-inch thick. Product shall be labeled as impact-safety glazing.
- C. GL-C: Not used.
- D. GL-D (Clear Ballistics-Resistant Glass): Global Security Glazing "Secur-Tem + Poly - UL Level 3 (Product Code SP311)" clear symmetrical glass-clad polycarbonate laminated unit in compliance with ASTM C1349 Kind GCP and ASTM C1036, of composition as required to meet UL 752 Level 3 performance requirements, nominal 1-5/64 inches thick, or accepted equal. Glazing shall be UL listed and labeled. Fabricate laminated sheets using laminator's standard process to produce units free from foreign substances and air or gas bubbles.
- E. GL-E (Fire-Rated Clear Safety Glass): "FireLite Plus" fire-rated, laminated, impact safety-rated, clear and wireless glass ceramic with premium polished surface finish, 5/16-inch (8-mm) thick, as manufactured by the Nippon Electric Glass Co. Ltd., or accepted equal. Product shall be UL listed and labeled as fire resistant with hose stream test and shall meet CPSC 16 CFR Part 1201 and ANSI Z97.1 test requirements and NFPA 80 and NFPA 257 test standards for fire-ratings scheduled.
- F. GL-F: Not used.
- G. GL-G (Fire-Rated Clear Glass): Nippon Electric Glass Co. Ltd. "FireLite" fire-rated, laminated, clear and wireless glass ceramic with premium polished surface finish, 3/16-inch (5-mm) thick, as distributed by Technical Glass Products, or accepted equal. Product shall be UL listed and labeled as fire resistant with hose stream test and NFPA 80 and NFPA 257 test standards for fire-ratings scheduled.

2.05 — UNFRAMED MIRRORS

- A. ~~Material: Clear float glass in compliance with ASTM C1503, Mirror Select Quality, not less than nominal 1/4-inch (6-mm) thick, and as specified herein.~~
- B. ~~Mirror Fabrication:~~
 - 1. ~~Cut mirrors to final sizes and shapes to suit Project conditions. Furnish mirrors in single-cut sizes for each location required, unless otherwise indicated.~~
 - 2. ~~Prepare cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.~~
 - 3. ~~Edge Treatment:~~
 - a. ~~Provide flat polished edges.~~
 - b. ~~Seal edges to prevent chemical or atmospheric penetration of glass coating. Sealer shall be compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at edges.~~
 - c. ~~Perform edge treatment and factory edge sealing immediately after cutting to final sizes.~~

HEAT TREATMENTS

- A. General Requirements: Comply with ASTM C1048 and as specified. Visual tongs marks will not be permitted. Maximum warpage shall be in accordance with LOF or PPG standards. Tempered glass shall have all lites within each series tempered by the same method.
- B. Heat Strengthened: In compliance with ASTM C1048, Kind HS, Condition A, roller hearth process only. Use throughout except where indicated to be tempered.
- C. Fully Tempered: In compliance with ASTM C1048, Kind FT, Condition A, and meeting ANSI Z97.1 test requirements, roller hearth process. Permanently label each lite in accordance with ANSI Z97.1.

GLAZING ACCESSORIES

- A. Glazing Sealant:
 - 1. For General Use: Single-component, high modulus, high-performance silicone; GE Silicones "Silicone Construction SCS1200 Sealant", or accepted equal. Furnish in color selected by Architect.
 - 2. For Butt Glazing: Single-component, high modulus, high-performance translucent silicone sealant; GE Silicones "Construction SCS1200 Silicone Sealant", or accepted equal.
 - 3. For Fire-Rated Glazing: Single-component, medium, high-performance silicone in compliance with listing requirements, as recommended in writing by the fire-rated glass manufacturer. Furnish in color selected by Architect.
- B. Gaskets, Setting Blocks, and Spacers for Non-Fire-Rated Glass: General Electric Type II preformed silicone rubber, of ASTM D2240 shore "A" durometer hardness within the ranges specified below to suit the specific installation conditions.
 - 1. Gaskets: In profiles indicated and of 50-80 Shore "A" hardness required for watertight construction; corners shall be vulcanized; color, black.
 - 2. Setting Blocks: 80, plus or minus 5 Shore "A" durometer hardness, anti-walk type, of length required for size and weight of glass.
 - 3. Spacers: 50-80 Shore "A" durometer hardness.
- C. Setting Blocks for Fire-Rated Glass: Types and sizes in compliance with listing requirements, as recommended in writing by the glass manufacturer.
- D. Glazing Tape:
 - 1. General Requirements: As recommended by sealant manufacturer for the specific installation conditions.
 - 2. Tape for Fire-Rated Glazing: As recommended by manufacturer of fire-rated glazing.
- E. Cleaners, Primers, and Sealers: As recommended in writing by manufacturers of glass and gaskets.

~~F. Mirror Attachment Devices:~~

- ~~1. Top and Bottom Moldings: Continuous stainless steel "J" molding with stainless steel countersunk fasteners. Bottom molding shall be designed to withstand mirror weight and top molding shall be designed to prevent mirror from coming away from wall along top edges. Fabricate moldings in single lengths for each installation area.~~
- ~~2. Mastic: Product produced specifically for setting mirrors by spot application, certified by both mirror manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirror will be installed, and in compliance with VOC requirements. Subject to compliance with requirements furnish Gunther Mirror Mastics "EZ Stic Mirror Adhesive Pads" (VOC 0 g/L) 3-inch diameter self-adhesive pads with release paper, or accepted equal.~~

2.07

2.08 FABRICATION

- A. Fabricate glass and other glazing products in sizes required to glaze openings indicated with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing standard to comply with system performance requirements.

2.08

2.09 INSULATING GLASS – GENERAL REQUIREMENTS

- A. General Requirements: Comply with requirements and recommendations of SIGMA TM-3000 "Glazing Guidelines for Sealed Insulating Glass Units" and recommendations of IGCC, and as specified.
- B. Spacer Bar: Mill finish aluminum except as otherwise specified, tubular type with welded, soldered, braised or bent corners; filled with dry air or argon gas as required for performance and containing desiccant.
- C. Edge Seal: Twin primary seals of polyisobutylene; secondary seal outside bar shall be of polysulfide or silicone elastomeric sealant and shall be bonded to both sheets of glass and spacer bar. Conform to ASTM E773 and E774 Class CBA or better.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify and ensure that surfaces and conditions are satisfactory for the installation of glazing materials.
- B. Ensure that glazing channels are free of burrs, irregularities, and debris, and coatings that could adversely affect the execution and quality of Work.
- C. Ensure that glass is free of edge damage and face imperfections.
- D. Ensure that glazing channels contain no deviations beyond allowable tolerances for the installation of sealant.
- E. Do not begin installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Field Measurements:

1. Measure size of frame or area to receive glazing.
2. Compute actual glass size, allowing for edge clearances.
3. Size glass for each opening within tolerances and dimensions established.
4. ~~Cut mirrors so that roll marks will be parallel to top and bottom edges.~~

B. Preparation of Surfaces:

1. General Requirements:
 - a. Remove protective coatings from surfaces to be glazed.
 - b. Clean glass and glazing surfaces to remove dust, oil, and other contaminants, and wipe dry.
2. ~~Mirrors: Comply with mastic manufacturer's printed installation instructions for preparation of substrates, including coating surfaces with mastic manufacturer's special bond coating where applicable.~~

3.03 INSTALLATION

A. General Requirements:

1. Install glass and associated materials in compliance with GANA's "Glazing Manual" and "Sealant Manual" except as otherwise indicated, specified, or recommended in writing by the manufacturers of the glass, glazing materials, frames, and associated materials; and in compliance with regulatory requirements.
2. Install glass with UL and other required permanent identification markings visible and legible on each lite after installation.
3. Install glazing to be watertight and airtight.
4. Unify appearance of each series of lites by setting each piece to match others, as nearly as possible, with pattern, draw, and bow oriented in the same direction.
5. Do not field cut, nip, or abrade glass.
6. Miter-cut and bond ends of gaskets together at corners to prevent gaskets from pulling away at corners.
7. Prevent glazing materials containing solvent or oil from coming into contact with laminated glass.
8. Set glazing tape flush with sight lines to fit openings exactly.
9. Install removable glazing stops and secure without displacement of glazing tape or gaskets.

- B. Fire-Rated Glass: In addition to general requirements install fire-rated glass in compliance with NFPA 80 and its listing requirements for fire ratings scheduled. Listing label shall be visible on each lite after installation.
- C. Ballistics-Resistant Glass: In addition to general requirements, install ballistics-resistant glass in compliance with its ballistics listing requirements.
- D. Fire-Rated Glass: In addition to general requirements install fire-rated glass in compliance with NFPA 80 and its listing requirements for fire ratings scheduled. Listing label shall be visible on each lite after installation.
- E. Butt Glazing:
 - 1. Provide frameless glazing intersections for locations indicated. Provide additional setting blocks at edges of glazing units so edge deflection does not exceed L/175.
 - 2. Apply primer and adhesion promoter, as required, in compliance with the manufacturer's printed instructions as recommendations.
 - 3. Fill joints completely with continuous glazing sealant, of type required, in compliance with the manufacturer's printed instructions. Apply sealant free of air pockets and voids. Neatly tool sealant smooth and even.
 - 4. Provide temporary blocking or stops to hold glass immobile until sealant has cured.

~~F. Mirrors:~~

~~1. General Requirements:~~

- ~~a. In addition to general requirements, install mirror units in compliance with the mirror manufacturer's printed instructions and the printed recommendations of the Mirror Division of GANA.~~
- ~~b. Install mirror units with continuous J-molding at bottom and spot applications of mastic in mirror field.~~
- ~~c. Mount mirrors accurately in place in a manner that avoids distorting reflected images.~~

~~2. J-Molding: Install continuous J-molding at bottom edge and securely attach to supporting wall framing with countersunk fasteners spaced no further than 16 inches on center.~~

~~3. Mastic: Prepare surfaces and apply mastic in compliance with the manufacturer's printed instructions but not less than one pad for each square foot of mirror area.~~

3.04 CLEANING

- A. Labels on Glass: Obtain permission to remove labels from colored glass and spandrel as soon as possible after glazing in order to avoid discoloration. No identification or caution markers permitted directly on glass surfaces. Markers may be placed across window, but attached to metal frames with ample space for air movement between marker and glass.
- B. Wash and polish both faces of glass in compliance with the glass manufacturer's printed instructions. Leave labels in place except as noted above until time of final cleaning.

~~C. Wash mirrors as recommended in writing by the mirror manufacturer and the Mirror Division of GANA using water and glass cleaner that are free from substances capable of damaging edges and coatings.~~

~~D.C.~~ Remove debris from the Site.

3.05 COMPLETION

- A. Upon completion, glass and associated Work shall be clean, watertight and airtight, and free from foreign adhering material, breakage, cracks, scratches, nicks, chips, tool marks, and other defects and damage.
- B. Each installation shall withstand normal temperature changes and wind loading without failure, including loss and breakage of glass, failure of sealants and gaskets to remain watertight and airtight, deterioration of glazing materials, and other defects.
- C. Required permanent identification markings shall be visible and legible on each lite.

3.06 PROTECTION

- A. Protect glazing from damage and deterioration until time of completion and acceptance by the Owner.
- B. Do not apply materials to glass surfaces other than specifically permitted by glass manufacturer.
- ~~C. Do not permit edges of mirrors to be exposed to standing water. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.~~
- ~~D.C.~~ Replace glass damaged by accidents, vandalism, and natural causes during construction period at no increase in Contract Amount or Contract Time.

END OF SECTION

LATH AND ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This SECTION describes the requirements for furnishing and installing metal lath, building paper, flashing panels, metal accessories, and associated flashings for portland cement plaster specified in SECTION 09 22 00 "PORTLAND CEMENT PLASTERING".
- B. Metal framing for exterior walls is specified in SECTION 05 40 00 "EXTERIOR METAL STUD FRAMING".
- C. Gypsum sheathing is specified in SECTION 06 16 43 "GYPSUM SHEATHING".
- D. Suspended metal framing and furring for portland cement plaster soffits is specified in SECTION 09 22 16 "NON-LOAD-BEARING METAL FRAMING".

1.02 QUALITY ASSURANCE

- A. Qualifications, Installer: Installer shall specialize in the installation of lath and accessories and able to show completed jobs of comparable size and complexity to that required for this Project. Installer shall use only skilled and properly trained persons to perform the Work.
- B. Industry Standard: Materials and application shall comply with recommendations contained in the Northwest Wall and Plaster Bureau (NWCB) "Stucco Resource Guide" except where specified or regulatory requirements exceed those recommendations.
- C. Regulatory Requirements: Lath and accessories and their application shall be in compliance with requirements of the applicable building code and other regulations. Refer to SECTION 01 41 00 "REGULATORY REQUIREMENTS" for further information.
- D. Testing Laboratory Services: As specified in Part 3.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's descriptive and technical data and illustrations, clearly marked to show specific proposed products, materials, finishes, and evidence of compliance with specified requirements. Include manufacturer's printed installation instructions, requirements for substrate preparation, and other items required for the successful completion of this Work.
- B. Installer's Qualification Data: Submit evidence that installer complies with specified qualification requirements. Include documentation of installer's prior experience including a list of successfully-completed jobs of similar scope and complexity to this Project. For each job include the job name, date of completion, and the names, addresses, and telephone numbers of the owner and architect-of-record.
- C. Certificates of Compliance: Submit manufacturers' written certifications that products supplied for installation comply with regulatory requirements and meet specified requirements.

PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver products and materials in original unopened packages, containers, or bundles with manufacturer's label intact and legible.
- B. Immediately remove items delivered in broken, damaged, rusted, or unlabeled condition from the Site.
- C. Protect metal lath, metal suspension materials, and metal accessories from moisture and other sources of damage.
- D. Store metallic materials and accessories indoors, off the floor, away from construction activity.
- E. Comply with additional requirements of the manufacturer.

COORDINATION

- A. Coordinate installation of lath and accessory Work with other Work that penetrates through or is mounted on portland cement plaster assemblies.
- B. Coordinate installation of flashing panels with the installation of metal framing.

PART 2 - PRODUCTS

2.01 METAL LATH

- A. Material: In compliance with ASTM C847 copper-bearing steel, ~~coated with rust-inhibitive paint after cutting, or zinc-coated~~ with hot-dip galvanized zinc coating in compliance with ASTM A653 G60 coating designation, and as follows:
 - 1. Self-Furring Lath for Wall Assemblies: U.S. nominal weight of 3.4 pounds per square yard, fabricated in diamond mesh pattern with evenly spaced indentations to hold lath approximately 1/4-inch away from solid surfaces.
 - 2. 3/8-Inch Rib Lath for Suspended Plaster Soffits: U.S. nominal weight of 3.4 pounds per square yard, fabricated in herringbone mesh pattern with 3/8-inch deep ribs.

2.02 BUILDING PAPER AND ASSOCIATED MATERIALS

- A. Building Paper: In compliance with FS UU-B-790a, Type I, Style 2, Grade D, 60 minute; Fortifiber "60 Minute Super Jumbo Tex", or accepted equal.
- B. Flashing Membrane: Fortifiber Building Systems "Fortiflash" self-adhesive flashing membrane, not less than 0.025-inch thick, width as required to suit application, or accepted equal.

2.03 FLASHING PANELS

- A. Product: Quickflash Weatherproofing Products, Inc. "Quickflash Weatherproofing Flashing Panels" consisting of a panel constructed of a combination of high-density polyethylene (HDPE) and low-density polyethylene (LDPE) and a flexible thermoplastic elastomer weatherproof seal, or accepted equal. Furnish specific flashing panel models to suit materials, sizes, and types of objects to be flashed.
- B. Sealant for Two-Piece Panels: Polyurethane in compliance with ASTM C920, Type S, Grade NS, Class 50, Use NT and as recommended in writing by the flashing panel manufacturer.

2.04 METAL ACCESSORIES

- A. Acceptable Manufacturers: Alabama Metal Industries Corporation (AMICO), California Expanded Metal Products Company (CEMCO), Dietrich Metal Framing, Keene Corp., Superior Metal Trim, and Western Metal Lath.
- B. Material: 99 percent pure zinc alloy in compliance with ASTM B69, except as otherwise specified. Plastic, aluminum, and galvanized steel are not acceptable, except as otherwise specified.
- C. Types: In compliance with ASTM C1063 and as follows. Coordinate depth with thicknesses and number of plaster coats required.
 - 1. Base Screeds: 1/2-inch deep with expanded metal wings.
 - 2. Weep Screeds: Style No. 7 with 3-1/2 inch metal wing and perforations to permit weeping.
 - 3. Casing Beads and Plaster Stops: Style No. 66 with expanded metal wings.
 - 4. Corner Beads: 3/16-inch bead unless otherwise indicated, with expanded metal wings.
 - 5. Corner Reinforcement: Cornerite, fabricated from expanded metal lath, not less than 1.75 pounds per square yard with 2-inch minimum legs.
 - 6. Strip Reinforcement: 6-inch wide strip of galvanized steel expanded metal lath; minimum 1.75 pounds per square yard.
 - 7. Joints:
 - a. Control Joints: Style No. 15 for flat surfaces and Style No. 30 for corners; furnish with expanded metal wings.
 - b. Expansion Joints: Style No. 40 with perforated metal wings.

2.05 ALUMINUM ACCESSORIES

- A. Manufacturer: Fry Reglet Corp., or accepted equal.
- B. Material: Extruded aluminum, not less than 0.050-inch thick, in compliance with ASTM B221 6063-T5 alloy-temper, with manufacturer's standard clear anodized finish.

C. Types:

1. Vented Drip Screed: Fry Reglet Corp. "DS-875-V-875".
2. Foundation Weep Screed: Fry Reglet Corp "FWS-75".
3. J-Molding: Fry Reglet Corp. "JPM-75".
4. Vented Soffit Molding: Fry Reglet Corp. "1680-V".
5. Corner Key Molding: Fry Reglet Corp. "PCM-150-150".
6. Key Reveal Molding: "PRZ-75-75".
7. Reveals:
 - a. JT-A: Fry Reglet Corp. "PCS-75-75" channel screed.
 - b. JT-B: Fry Reglet Corp. "PCS-75-200" channel screed.
 - c. JT-C: Fry Reglet Corp. "PCS-75-600" channel screed.
 - d. JT-D: Not used.
 - e. JT-E: Fry Reglet Corp. PCS-75-25/25" channel screed.
 - f. JT-F: Fry Reglet Corp. "PCS-75-75" 2-piece drift joint (3/4-inch size) and "PCS-75-200" 2-piece drift joint (2-inch size), as indicated.

2.06 FASTENERS

- A. General Requirements: Unless otherwise specified, select proper size, type, material, and finish for each application.
- B. Staples for Attachment of Building Paper: In compliance with FS FF-N-105.
- C. Screws for Attachment of Metal Lath and Metal Accessories: Corrosion-resistant steel drill screws in compliance with ASTM C1063, conforming to ASTM C1002 for attachment to metal framing 25-gauge (0.0247-inch) and lighter and ASTM C954 for attachment to metal framing 20-gauge (0.0396-inch) and heavier; lengths as required.

2.07 MISCELLANEOUS MATERIALS

- A. Metal Framing and Furring: As specified in SECTION 09 22 16 "NON-LOAD-BEARING METAL FRAMING".
- B. Provide additional components and materials required for a complete installation.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify that conditions are satisfactory for the installation of lath and accessories.

- B. Ensure that all pipe, conduit, and similar materials have been installed, inspected, and accepted prior to beginning installation.
- C. Do not begin installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Install materials in conformance with the referenced standards, manufacturer's printed instructions and recommended details, as indicated, and as specified.

3.03 INSTALLATION OF FLASHING PANELS

- A. General Requirements: Install flashing panels at all plumbing and electrical penetrations in exterior vertical walls. Coordinate installation of flashing panels with building paper and flashing membrane.
- B. Electrical Boxes: At electrical boxes, ensure that flashing panel collars are flush with box opening edges.
- C. Plumbing Pipes and Electrical Conduits:
 - 1. Place flashing panels over pipes and conduits. Set panels tight to sheathing.
 - 2. Install two-piece flashing panels at pipes with sweated-on exterior tees. Cut flashing panel scores to size of pipe, place bottom panel under pipe, and snot top panel to bottom panel over pipe. Prepare surfaces and apply joint sealant between flashing panel and pipe in compliance with requirements specified in SECTION 07 92 00 "JOINT SEALANTS".
- D. Ensure that flashing panels create friction-tight weatherproof seals with penetrating objects.
- E. Securely fasten flashing panels to supporting metal framing or metal backing at top edge only to prevent displacement.

3.04 INSTALLATION OF BUILDING PAPER AND FLASHING MEMBRANE

- A. Building Paper:
 - 1. General Requirements:
 - a. Install building paper using double layer installation method.
 - b. Install each layer from lowest level, working up shingle fashion in a manner to shed water.
 - c. Install paper in longest lengths practicable to minimize number of joints.
 - d. Lap paper over head flashings, base screeds, and over flanges of sill flashings.
 - e. Secure paper with minimum number of fasteners to hold paper in place until covered by other materials and prevent tearing and blow-off.
 - f. When complete, both layers of paper shall be flat, without excessive warps or bulges, and free from unnecessary holes, cuts, tears, and other damage and defects.

- d. Press flashing membrane firmly in place to achieve full bond with substrate.

3.05 INSTALLATION OF METAL LATH

- A. General Requirements: Install metal lath in compliance with ASTM C1063 except as otherwise specified and where regulatory requirements are more stringent, and as indicated.
- B. Walls:
 - 1. Install metal lath over building paper and gypsum sheathing as indicated.
 - 2. Start first course at bottom of wall and work up. Extend lath over the attachment flange of screed. Stagger vertical joints. Lap end joints not less than 1-inch and horizontal joints not less than 1/2-inch.
 - 3. Insert lath as far as possible into reentrant space of metal frames, and notch to pass around jamb anchors.
 - 4. Hold lath 1/4-inch clear of electrical boxes, columns, and similar items projecting through the lath. Cut lath at control joints.
 - 5. Attach lath to metal framing at 6-inches on center. Securely tie ends of lapped sheets not occurring over supports with tie wire, spaced 9-inches on center maximum.
- C. Exterior Suspended Soffits:
 - 1. Install lath taut to soffit suspension support system with long dimension of sheets perpendicular to furring members.
 - 2. Secure metal lath to furring members with tie wire spaced maximum of 6-inches on center.
 - 3. Lap ends of sheets on furring members not less than 1-inch. Stagger sheet end joints. Wire tie edge laps between furring members at maximum of 9-inches on center.

3.06 INSTALLATION OF METAL ACCESSORIES

- A. General Requirements:
 - 1. Install metal accessories in single lengths wherever length of run does not exceed longest standard stock length. Connect lengths of accessories as recommended by the manufacturer to ensure a continuous line.
 - 2. Connect lengths of accessories as recommended by the manufacturer to ensure a continuous line.
 - 3. Bring grounding edge of accessories to true lines, plumb, level, and straight with a tolerance of not more than 1/8-inch in 5-feet.
 - 4. Install accessories to provide required depth of plaster and to bring plaster surface to required plane.

5. Miter or cope exposed accessories at corners with hairline joints and seal with sealant as specified in SECTION 07 92 00 "JOINT SEALANT". Seal butt splices in the same manner.
 6. Fasten accessories at both ends and at a maximum of 12-inches on center along sides and as required to prevent dislodging or misalignment by subsequent operations. Wire tie to metal lath or metal framing.
- B. Reinforcement:
1. Corner Reinforcement: Install continuous corner reinforcement full length of internal corners except where plaster will not be continuous from one plane to an adjacent plane.
 2. Strip Mesh: Install strip mesh diagonally at corners of lathed openings and secure rigidly in place.
- C. Control Joints for Portland Cement Plaster: Install control joints where indicated at spacing not more than 15-feet on center, both ways. Maximum area within control joints shall not exceed 144 square feet and ratio of width to length shall not exceed 2.5 to one (2.5:1). Attach control joints directly to base lath.
- D. Expansion Joints: Install where indicated. Provide with sliding type splice plates at butted joints and with matching end closures where applicable. Install with attachment only to base lath; do not continue or tie lath across joint.
- E. Weep Screeds: Install weep screeds at bottom of walls, wall openings, and where indicated. Terminate paper backing and lath on the attachment flange of the screed.
- F. Beads:
1. General Requirements: Set beads level, plumb, and true to line. Shim as required and align joints with concealed splices or tie plates.
 2. Casing Beads and Plaster Stops:
 - a. Install casing beads and plaster stops to provide a minimum 1/8-inch clearance between adjacent construction and termination points of surfaces to receive plaster.
 - b. Provide beads where plaster abuts dissimilar construction and at perimeter of openings where edges or plaster will not be concealed by other Work.
 3. Corner Beads: Install corner beads at external corners.

3.07 INSTALLATION OF ALUMINUM ACCESSORIES

- A. General Requirements:
1. Install aluminum accessories and fasten in place as required to prevent dislodging or misalignment by subsequent operations.
 2. Install moldings in full factory lengths wherever possible. Connect lengths of accessories as recommended by the manufacturer to ensure a continuous line.

3. Install accessories to provide required depth of plaster and to bring plaster surface to required plane.
4. Bring grounding edge of accessories to true lines, plumb, level, and straight.
5. Accurately cut and seal molding joints; miter corners.
6. Fasten at both ends and at a maximum of 12-inches on center along sides.

B. Types: Install where indicated.

3.08 FIELD QUALITY CONTROL

A. Testing Laboratory Services:

1. A representative from the Testing Laboratory shall be at the Site full time during the installation of building paper, metal lath, metal accessories, and flashing associated with portland cement plaster.
2. Upon successful completion of the installation the Testing Laboratory shall submit written certification to the Owner and Architect that materials and their installation are in compliance with the requirements of the Contract Documents.

3.09 COMPLETION

- A. When complete lath and accessories shall be securely fastened to supporting Work, accurately placed to required position, and plumb, level, and square as required.
- B. Metal lath shall be positioned to achieve required plaster thicknesses and so finished plaster surfaces will be true-to-plane as specified in SECTION 09 24 00 "PORTLAND CEMENT PLASTERING".

3.10 PROTECTION

- A. Protect lath and accessories from damage and deterioration until covered with plaster.
- B. Do not allow construction activity or traffic near lath and accessories without adequate protection.

END OF SECTION

SECTION 10 21 23.16

CUBICLE CURTAIN TRACK AND HARDWARE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This SECTION describes the requirements for furnishing and installing cubicle curtain track and hardware, carriers for shower curtains, and associated materials.
- B. Shower curtains are specified in SECTION 10 28 10 "TOILET, BATH, AND JANITORIAL ACCESSORIES".

1.02 QUALITY ASSURANCE

- A. Source Limitations: Obtain cubicle curtain track and hardware through one source from a single manufacturer.
- B. Qualifications, Installer: Installer shall be experienced in the installation of cubicle curtain track of the type required.
- C. Regulatory Requirements: Track and installation shall be in compliance with requirements of the applicable building code and other regulations. Refer to SECTION 01 41 00 "REGULATORY REQUIREMENTS" for further information.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's descriptive and technical data and illustrations, clearly marked to show specific products, materials, and compliance with requirements. Include manufacturer's printed installation instructions.
- B. Shop Drawings: For each type of track, submit Shop Drawings showing layouts, installation details, relationship to adjoining Work, and attachment to supporting Work.
- C. Samples: Submit 12-inch long samples of each type of track with each type of carrier.
- D. Maintenance Data: Furnish manufacturer's printed recommendations for the care and maintenance of track finish to the Owner.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in the manufacturer's original protective packaging and other means necessary to prevent damage and deterioration during shipment, handling, and storage. Maintain protective coverings in place and in good repair until removal is necessary. Packaging shall be properly labeled for identification and installation purposes.
- B. Store products inside enclosed storage facilities or enclosed building in a clean, dry, secure location, protected from construction activities, until ready for use in the Work. Maintain storage spaces and products within temperature and humidity ranges recommended by the manufacturer.
- C. Comply with additional requirements of the manufacturer.

1.05 JOB CONDITIONS

- A. Do not install track until finish painting in installation areas is complete and dry, other Work above ceilings is complete, and ambient temperature and humidity conditions are functioning, controlled, and maintained at the levels required when Project is occupied for its intended use.

1.06 COORDINATION

- A. Supply drawings, templates, and data necessary for proper preparation of framing and other Work supporting track. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other Work to ensure that tracks can be supported and installed as required.
- B. Prepare and utilize accurately-scaled coordination drawings consisting of reflected ceiling plans on which the following items are shown and coordinated with each other, based on input from installers of the items involved: suspended ceiling components, supporting members to which track will be attached, and items mounted in and on ceilings including, but not limited to, lighting fixtures, mechanical air supply diffusers and return grilles, speakers, fire and smoke detectors, fire sprinkler components, and access panels. Refer to applicable SECTION in DIVISION 01 - GENERAL REQUIREMENTS for further information on coordination drawings.
- C. Obtain accurate field measurements before fabrication of track and show measurements on the final Shop Drawings.

PART 2 - PRODUCTS

2.01 CUBICLE CURTAIN TRACK AND HARDWARE

- A. Track: Modified channel track designed for wheeled carriers, fabricated from manufacturer's standard extruded aluminum with clear satin anodized finish, not less than 1-3/8-inches wide by 3/4-inch high by 0.050-inch thick, suitable for surface mounting on gypsum board and acoustical ceilings, and as specified hereinafter. Subject to compliance with requirements furnish one of the following:
 - 1. Salsbury Industries "Series 19100" with "19103" two-wheel curtain carriers.
 - 2. Imperial Fastener Co., Inc. "IFC-98" with "IFC-100" two-wheel curtain carriers.
 - 3. InPro Corp. "Optitrack" with "C5038" two-wheel curtain carriers.
- B. Track Configurations: Furnish in manufacturer's standard or custom, factory-produced straight, curved, and bent sections to suit layouts indicated. Furnish track in single-length pieces and longest lengths to eliminate joints to greatest extent practicable.
- C. Track Hardware:
 - 1. Track Fittings: Furnish track complete with manufacturer's standard splicers, coupling and joining sleeves, end caps, end stops, and other components recommended by the manufacturer for a secure and operational installation. Fittings shall be compatible with track and shall match color and appearance of track where exposed to view in the installation.

2. Curtain Carriers: As specified hereinbefore except with 15-inch long stainless steel bead chain with hard aluminum hook and eyelet. Furnish carriers in quantity required each shower curtain, 1 per curtain grommet.

2.02 ASSOCIATED MATERIALS FOR TRACKS

A. Fasteners:

1. Nonferrous or corrosion-resistant plated sheet metal screws, as indicated or as required to suit installation conditions indicated.
2. Provide fasteners within 6- to 8-inches from track ends and spaced at not over 16-inches on center in between, unless otherwise indicated.

B. Suspension Materials:

1. Metal Plates and Channels: As specified in SECTION 09 22 16 "NON-STRUCTURAL METAL FRAMING".
2. Hanger and Bracing Wire and Attachments to Structure: As specified in SECTION 09 51 00 "ACOUSTICAL CEILINGS", except gauges as indicated.

2.03 FABRICATION

- A. Shop-fabricate and assemble track in longest lengths practicable to minimize joints and field connections.
- B. Carefully match track sections to produce continuity of line and design. Fit sections accurately together at joints with hairline joints.
- C. If not shop-assembled, pre-fit and mark section at shop to ensure proper and expeditious field assembly.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify that conditions are satisfactory for the installation of cubicle curtain track and hardware.
- B. Do not begin installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protection:

1. Protect adjacent surfaces and finishes from damage during installation of track and hardware.
2. Protect products from damage during field handling and installation.

- B. Surface Preparation: Prepare surfaces to receive track in compliance with the manufacturer's printed instructions.

3.03 INSTALLATION

- A. Install cubicle curtain track and hardware in compliance with manufacturer's printed instructions, accepted Shop Drawings, as indicated, and as specified.
- B. Install track true to position, accurately aligned with adjacent Work, level, and complete with accessories and carriers.
- C. Accurately fit sections together in proper alignment with hairline joints.
- D. Securely fasten track to supporting Work as indicated to prevent movement.

3.04 REPAIRS

- A. Repair minor damage in compliance with the manufacturer's printed instructions.
- B. Remove components that cannot be successfully repaired and provide new acceptable Work at no increase in Contract Amount or Contract Time.
- C. When complete, repairs and replacement Work shall match original undamaged Work in all aspects.

3.05 CLEANING

- A. After completion of installation, clean track and carriers using cleaning materials and procedures recommended in writing by the manufacturer without causing damage.

3.06 COMPLETION

- A. When complete, track shall be accurately aligned at joints and carriers shall travel along track smoothly, quietly, and without binding.
- B. Track shall be securely fastened to supporting Work to prevent movement.
- C. Exposed surfaces of track shall be clean and free from scratches, tool marks, and other damage and defects.

3.07 PROTECTION

- A. Protect track and hardware from damage until time of completion and acceptance by the Owner.
- B. Do not allow track to be exposed to construction activity or traffic without adequate protection.
- C. Maintain track in clean condition until accepted. Prevent debris from accumulating in track.
- D. Comply with additional recommendations of the manufacturer.

END OF SECTION

SECTION 10 26 10

WALL AND CORNER GUARDS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This SECTION describes the requirements for furnishing and installing wall and corner guards and associated materials.

1.02 QUALITY ASSURANCE

- A. Source Limitations: Obtain prefabricated wall and corner guards through one source from a single manufacturer.
- B. Reference Standard: Fabrication and installation of stainless steel sheet metal wall protection paneling shall be in compliance with applicable recommendations of the latest edition of the SMACNA "Architectural Sheet Metal Manual".
- C. Qualifications:
 - 1. Fabricator of Stainless Steel Wall Protection: Fabricator shall be experienced in fabricating metal fabrications of the types required and able to document prior experience upon request.
 - 2. Installer: Installer shall be experienced in the installation of wall and corner guards of the types required.
- D. Regulatory Requirements:
 - 1. Products and their installation shall be in compliance with requirements of the applicable building code and other regulations. Refer to SECTION 01 41 00 "REGULATORY REQUIREMENTS" for further information.
 - 2. Fire-Test Response Characteristics:
 - a. When wall and corner guards are tested in accordance with ASTM D635, materials shall be determined to be self-extinguishing.
 - b. When wall and corner guards are tested in accordance with ASTM E84, Flame Spread Index shall be 25 or less and Smoke Developed Index shall be 450 or less.
 - 3. Fire-Rated Corner Guards: Fire-rated corner guards shall be UL listed and labeled.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's printed product data clearly marked to show materials, components, and finishes. Include manufacturer's printed installation instructions.
- B. Samples:
 - 1. Submit 12-inch long sample of each type of wall and corner guard with specified materials, colors, and finish.

- 2. Submit 12-inch square sample of wall protection panel and 12-inch long length of each type of molding.
- C. Shop Drawings - Stainless Steel Wall Protection Panels: Submit Shop Drawings showing layouts, elevations, sizes, general features, materials, finishes and relationship to adjacent Work. Include details of attachment to supporting Work.
- D. Test Reports: Submit UL test report for each fire-rated corner guard assembly.
- ~~D-E.~~ Maintenance Data: Furnish manufacturer's printed recommendations for the care and maintenance of wall and corner guards to the Owner. Include recommended maintenance products, methods, and procedures and specialized tools.
- ~~E-F.~~ Warranty: Submit review copy of manufacturer's warranty.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in the manufacturer's original protective packaging and other means necessary to prevent damage and deterioration during shipment, handling, and storage. Maintain protective coverings in place and in good repair until removal is necessary. Packaging shall be properly labeled for identification and installation purposes.
- B. Store materials flat in a cool, dry place out of direct sunlight and protected from damage. Maintain temperature within range recommended by the manufacturer.
- C. Comply with additional requirements of the manufacturer.

1.05 JOB CONDITIONS

- A. Maintain temperature and humidity conditions in installation areas in compliance with manufacturer's printed recommendations for at least 24 hours prior to and during installation, and for not less than 48 hours thereafter.
- B. Do not install wall and corner guards until finish painting is complete and dry in installation areas.
- C. Provide adequate continuous ventilation as required for the primers, sealers, and adhesives used, but in no case for a time less than that recommended by the manufacturer for full drying or curing.

1.06 COORDINATION

- A. Furnish drawings, templates, and data necessary for proper preparation of partition framing, gypsum board, and other Work supporting or adjoining wall and corner guards.
- B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other Work to ensure that wall and corner guards can be supported and installed as indicated.
- C. Obtain accurate field measurements before fabrication and show measurements on the final Shop Drawings.

1.07 WARRANTY

- A. Furnish to the Owner a written warranty, executed by the manufacturer, stating that wall and corner guards will be free from defects in materials and workmanship during the warranty period.

- B. During warranty period, remove defective Work and provide new replacement Work at no cost to the Owner.
- C. Warranty period shall be for five (5) years from the date of Substantial Completion.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Construction Specialties, Inc. as specified as the basis-of-design, or accepted equal by InPro Corp.

2.02 ~~SURFACE-MOUNTED CORNER GUARDS~~

A. ~~Products:~~

- 1. ~~CG-1 (Plastic Covered): Construction Specialties, Inc. "SM-20" with 2-inch legs for right angle corners and "SSM-20" for splayed corners, or accepted equal. Furnish with concealed retainer, plastic cover, and trim.~~
- 2. ~~CG-2 (Plastic Covered, End of Wall Type): Construction Specialties, Inc. "FSC-25", continuous, flush-mounted guard with 2-inch legs, or accepted equal. Furnish with concealed retainer, plastic cover with 1/4-inch radius, and trim.~~
- 3. ~~CG-3 (Stainless Steel): Construction Specialties, Inc. "CO-08" fabricated from 16-gauge, Type 304 stainless steel with No. 4 satin finish with graining parallel to length, or accepted equal. Furnish with strippable plastic film to protect finish.~~

B. ~~Components:~~

- 1. ~~Concealed Retainers: Mill finish extruded aluminum in compliance with ASTM B221, 6063-T6 alloy temper, formed to receive plastic cover, not less than 0.062-inch thick, continuous.~~
- 2. ~~Plastic Cover: As specified hereinafter in Article titled "Plastic Cover Material".~~
- 3. ~~Trim: Manufacturer's standard preformed snap-on cover of profile, color, and texture to match plastic cover.~~

- C. ~~Lengths: Full height, in single-length piece only from top of wall base to bottom of coiling, unless otherwise indicated.~~

2.02 FLUSH-MOUNTED CORNER GUARDS

A. Products:

- 1. CG-1 (Non-Rated): Complete assembly with concealed retainer, plastic cover, and trim.
 - a. 90-Degree Corners: Construction Specialties, Inc. "FS-20N" with 3-inch wide legs and snap-on angled plastic cover with 1/4-inch radius, or accepted equal.

- b. Angled Walls: Construction Specialties, Inc. "FS-10MN" with 3-inch wide legs and snap-on angled plastic cover with 1-1/4 inch radius, or accepted equal.
- c. Wall Ends: Construction Specialties, Inc. "FSC-25N" with 2-inch wide legs, snap-on U-shaped plastic cover with 1/4-inch radius, and of widths to suit installation locations, or accepted equal.

2. CG-1 (One-Hour Fire-Rated):

- a. 90-Degree Corners: Continuous assembly with 3-inch wide legs, concealed retainer, snap-on angled plastic cover with 1-inch radius, trim, and accessories; Construction Specialties, Inc. "FS-10N-1R", or accepted equal.
- b. Angled Walls: Construction Specialties, Inc. "FS-10MN-1R" with 3-inch wide legs and snap-on angled plastic cover with 1-1/4 inch radius, or accepted equal.

B. Components:

- 1. Concealed Retainer: Extruded aluminum in compliance with ASTM B221 6063-T6 alloy-temper, nominal 0.062-inch thick, continuous, formed to receive snap-on cover, and with tapered edges for embedment in gypsum joint treatment materials and pre-punched for fasteners.
- 2. Plastic Cover: As specified in Article titled "Plastic Cover Material".
- 3. Trim:
 - a. Gaskets: Manufacturer's standard, formed of plastic cover material, black color.
 - b. Metal Base Closure: Manufacturer's standard aluminum, of height to match adjacent wall base.
 - c. Foam Cushion: Manufacturer's standard Neoprene.
- 4. Accessories for Fire-Rated Corner Guards:
 - a. Fire Barrier: Manufacturer's standard, in compliance with listing requirements.
 - b. Fire Barrier Sealant: Manufacturer's standard, in compliance with listing requirements.

- C. Lengths: Furnish in single-length pieces only. Retainer shall extend from top of floor to 2-inches above finish ceiling. Plastic cover shall extend from top of wall base to 2-inches above finish ceiling.

2.03 CRASH RAIL / BUMPER RAILS-(BR)

A. Products:

- 1. BR-1: Construction Specialties, Inc. "~~FR-225~~", ~~2-1/4-inches high by 3/4-inch thick~~ "SCR-48N", 6-inches high by 1-1/4 inches thick continuous rail with concealed retainer, cushion insert, snap-on plastic cover, and trim.

B. Components:

1. Concealed Retainer: Continuous Clips, fabricated of extruded aluminum in compliance with ASTM B221 6063-T6 alloy-temper, not less than 0.063-inch nominal 0.062-inch thick, 1-1/2 inches wide except 3 3/16-inches wide for cover splices, and formed to receive snap-on cover and cushion insert, and equipped with continuous PCV cushion insert.
2. Cushion Insert: Recycled plastic cover material, continuous.
- 2.3. Plastic Cover: As specified hereinafter in Article titled "Plastic Cover Material".
- 3.4. Trim: Manufacturer's standard end caps and outside corner assemblies; matching cover material.

C. Lengths: Furnish in single-length pieces only for each run indicated or required.

D. Assembly: Shop-preassemble components to greatest extent practicable to minimize field assembly.

2.04 CRASH RAILS (CR)

A. Products:

1. CR-1: Construction Specialties, Inc. "SCR-64", 8-inch high by 1-1/4 inches thick continuous rail with concealed retainer, snap-on plastic cover, and trim.

B. Components:

1. Concealed Retainer: Continuous, fabricated of mill finish extruded aluminum in compliance with ASTM B221 6063-T6 alloy-temper, not less than 0.063-inch thick, formed to receive snap-on cover and cushion insert, and equipped with continuous resilient cushion insert.
2. Plastic Cover: As specified hereinafter in Article titled "Plastic Cover Material".
3. Trim: Manufacturer's standard endcaps and outside corner assemblies; matching cover material.

C. Lengths: Furnish in single-length pieces only for each run indicated or required.

D. Assembly: Shop-preassemble components to greatest extent practicable to minimize field assembly.

2.04

2.05

WALL PROTECTION PANELS (WPP)

A. WPP-1 (Sheet Plastic): Construction Specialties, Inc. "C/S Acrovyn High Impact Wall Coverings", 0.060-inch thick with square edges and lightly textured finish with matte sheen, or accepted equal. Furnish with manufacturer's standard continuous molding trim for inside and outside corners, wainscot, panel joint trim, and as required for complete installation. Furnish sheeting in sizes to minimize joints in each installation area.

1. Sheeting colors are noted in SECTION 09 00 00 "FINISHES".

2. Trim color will be selected by the Architect from the manufacturer's full range of standards.
- B. WPP-2 (Sheet Stainless Steel): Rigidized Metal "No. 5 WL" or Ardmore Textured Metal "No. 5-SM", not less than 22-gauge (0.0312-inch thick) with 2B finish. Furnish with continuous molding trim for inside and outside corners, exposed edges, panel joint trim, and as required for complete installation, fabricated of Type 430 stainless steel with 2B finish.
- C. WPP-3 (Plastic Laminate Covered ~~Plywood~~ Fire Retardant Composite Core): Specified in SECTION 06 20 00 "FINISH CARPENTRY".

2.05

2.06

PLASTIC COVER MATERIAL (Indicated as "Vinyl Cover")

- A. Product: Modified polyethylene terephthalate (PETG) formula containing no persistent bioaccumulative toxins (PBTs), bisphenol A (BPA), or halogenated fire retardants; completely recyclable; Construction Specialties, Inc. "Acrovyn 4000", or accepted equal.
- B. Thickness: Not less than 0.078-inch thick.
- C. Texture: "Shadowgrain" for wall guards and "Suede" for wall coverings.
- D. Sheen: Matte.
- E. Colors: As noted in SECTION 09 00 00 "FINISHES". Other colors will be selected by the Architect from the manufacturer's full range of standards. Components shall be of the same dye lot or color-matched with a Delta E difference of no greater than 1.5 using the Hunter (Lab) Scale.

2.06

2.07

INSTALLATION MATERIALS

A. ~~Mastic Adhesive: Water-based, non-hazardous, VOC-compliant types as recommended in writing by the guard manufacturer to suit job conditions.~~

~~B.~~A. Fasteners:

1. General Requirements: Furnish types suitable for supporting wall construction encountered, sized for adequate support of guards, and with non-corrosive electroplated finish compatible with materials being fastened.
2. Concrete or Masonry: Wedge or expansion-shield bolts.
3. Metal-Framed Partitions:
 - a. Corner Guards: Screws as specified in SECTION 09 29 00 "GYPSUM BOARD" except screws for fire-rated corner guards shall be in compliance with their listing requirements.
 - b. ~~Crash Rail / Bumper Rails and Crash Rails:~~ Toggle bolts.

2.07

2.08

FABRICATION - STAINLESS STEEL WALL PROTECTION PANELS

- A. Fabricate stainless steel wall protection panels in accordance with the accepted Shop Drawings, specified reference standard, and as specified.

- B. Shop fabricate and assemble wherever practicable, ready for installation at the Site. If not shop assembled, prefit at shop to assure proper and expeditious field assembly.
- C. Form sheet metal to fit snugly, with exposed edges folded under not less than 1/2-inch, and without sharp edges, fractures, fabrication marks, and other defects.
- D. Form seams neatly, and make straight. Fabricate non-moving seams with flat-lock seams.
- E. Provide expansion joints as required to permit normal expansion and contraction without straining of metal, joints, or fasteners. Provide at material junctions and as required straight runs. Unless otherwise indicated, select joint type best suited and least obtrusive for conditions of installation.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify that conditions and substrates are satisfactory for installation of wall and corner guards.
- B. Do not begin installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection:
 - 1. Protect adjacent surfaces and finishes from damage during installation of wall and corner guards.
 - 2. Protect products from damage during field handling and installation.
- B. Materials Acclimation: Unless otherwise recommended by the manufacturer, acclimate materials in areas of installation in compliance with the manufacturer's printed recommendations for at least 24 hours prior to installation.
- ~~C. Surface Preparation for Products Installed with Mastic Adhesive:

 - 1. Comply with manufacturer's printed recommendations for surface preparation.
 - 2. Remove dirt, oil, grease, incompatible primers, and other substances that could impair adhesive bond.
 - 3. Prepare substrates to achieve a smooth, dry, clean surface that is free of flaking, unsound coatings, cracks, and other defects.
 - 4. Prime and seal substrate when and as recommended by the manufacturer.~~

3.03 INSTALLATION

- A. General Requirements:
 - 1. Install wall and corner guards in compliance with the manufacturer's printed instructions, as indicated, and as specified.

2. Set wall and corner guards level, plumb, true to required position, properly aligned with adjacent Work, and securely fastened to supporting Work to prevent movement.
3. Secure retainers for firm bearing against backup surfaces without overstressing or damaging fastenings. Ensure that all fastenings are concealed.

B. ~~Surface Mounted~~ Flush Non-Rated Corner Guards:

1. Install corner guards continuous from top of ~~wall base~~ floor to required heights.
2. Securely fasten ~~aluminum concealed~~ retainer to wall framing with two fasteners spaced 1-1/2 inches from ends and not more than 18-inches on center in between. Extend retainer onto adjacent gypsum board and leave ready for embedment in gypsum joint treatment materials specified in SECTION 09 29 00 "GYPSUM BOARD".
3. Install snap on plastic cover and trim.
4. ~~Install stainless steel corner guards with full-spread mastic adhesive. Remove excess adhesive from adjacent surfaces as installation proceeds.~~

C. Flush Fire-Rated Corner Guards:

1. Install concealed retainer and accessories in compliance with their listing requirements. Separately fasten fire barrier and concealed retainer to metal framing.
2. Install trim components.

~~C-D.~~ Crash Rail / Bumper Rails and Crash Rails:

1. ~~Install bumper rails and crash rails at height indicated above finished floor. Install crash rail / bumper rails at heights indicated above finish floor.~~
2. ~~Securely fasten continuous aluminum retainer to wall framing with fasteners spaced 1-1/2 inches from ends and not more than 16-inches on center in between. Securely fasten retainer clips to wall framing, spaced no further apart than 16-inches on center.~~
3. Install continuous cushion inserts, snap on plastic covers, endcaps, and outside corner assemblies. Neatly miter inside corners, unless otherwise indicated. Where splices occur in horizontal runs, splice ~~aluminum retainer~~ cushion inserts and plastic cover at different locations along the run 1-inch apart over splice clips.

~~D-E.~~ Sheet Plastic Wall Protection Panels (WPP-1):

1. Mastic Adhesive:
 - a. Mix and apply adhesive in compliance with the manufacturer's printed instructions. Provide safety precautions during mixing and application as recommended by the adhesive manufacturer.
 - b. Apply adhesive to substrate with notched trowel or other suitable tool as recommended in writing by the manufacturer to ensure uniform application and complete bonding of materials to substrate. Clean trowel and rework notches as necessary to ensure proper application.

- c. Apply no more adhesive at any time than can be covered by other materials within the recommended working time of the adhesive.
 - d. Do not soil adjacent walls, bases, or other surfaces with adhesive. Remove adhesive from exposed surfaces as installation proceeds. Promptly remove spillage as occurs.
- 2. Trim:
 - a. Install continuous trim, level and plumb, at inside and outside corners, exposed panel edges, and joints between panels. Accurately position to required locations and align with adjacent Work.
 - b. In each installation area, install trim in maximum lengths to minimize joints.
 - c. Align adjacent pieces and butt ends snugly together without gaps.
- 3. Panels:
 - a. Install wall guard panels and trim in adhesive. Allow for expansion as recommended by the manufacturer.
 - b. Accurately position materials to required locations; ensure full contact with adhesive.
- 4. Sealant: Seal panels to trim, and trim to adjoining Work, as required to completely waterproof panel system. Remove excess sealant from exposed faces as installation progresses. Comply with requirements specified in SECTION 07 92 00 "JOINT SEALANTS".

E.F. Stainless Steel Wall Protection Paneling (WPP-2):

- 1. Install stainless steel paneling with full spread mastic adhesive and concealed fasteners in compliance with the accepted Shop Drawings, as indicated, and as specified.
- 2. Apply mastic adhesive as specified hereinbefore for sheet plastic wall protection panels.
- 3. Field fabricate only those items that cannot be fabricated in the shop. Comply with requirements specified for shop-fabrication.
- 4. Perform cutting, fitting, drilling, and similar Work as required to accommodate the Work of other SECTIONS.
- 5. Fit and install paneling and trim to ensure continuity of line, pattern, and design. Carefully match and align exposed Work.
- 6. Furnish paneling complete with all associated trim, corner plates, concealed cleats, clips, joint covers, shims, and similar items as required for a complete installation.

F.G. Plastic Laminate Wall Protection Panels (WPP-3): Specified in SECTION 06 20 00 "FINISH CARPENTRY".

3.04 CLEANING AND REPAIRS

- A. Clean wall and corner guards in compliance with the manufacturer's printed instructions without damaging finishes.
- B. Remove damaged components and provide new replacement Work, matching adjacent Work, at no additional cost to the Owner.

3.05 COMPLETION

- A. When complete, each guard assembly shall be set square, plumb and level, accurately aligned and securely anchored.
- B. End and corner accessories shall be accurately aligned with running components, and joints between adjoining components shall be neatly and closely fitted.
- C. Exposed surfaces shall be clean and free from scratches, nicks, dents, tool marks, stains, discoloration, and other defects and damage.
- D. Colors and textures shall match accepted samples.

3.06 PROTECTION

- A. Protect wall and corner guards from damage and deterioration until time of completion and acceptance by the Owner.
- B. Do not allow construction activity or traffic near completed Work without adequate protection.
- C. Use protective materials that can be easily removed without leaving residue, permanent stains, or other damage.

END OF SECTION

SECTION 11 70 00

HEALTHCARE EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This SECTION describes requirements for:
 - 1. Furnishing and installing healthcare equipment noted to be furnished and installed by the Contractor.
 - 2. Installing healthcare equipment designated to be furnished by the Owner for installation by the Contractor.
 - 3. Coordinating installation and utility requirements for healthcare equipment.

1.02 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Furnish inserts for embedment in concrete surfaces as required. Inserts embedded in concrete are specified to be installed under applicable SECTIONS of DIVISION 03 - CONCRETE.

1.03 QUALITY ASSURANCE

- A. Qualifications, Installer: Installer shall be acceptable to the applicable equipment manufacturer and shall have completed installations similar in material, design, and extent to that required for this Project which have resulted in a record of successful in-service performance.
- B. Regulatory Requirements: Equipment and installation shall be in compliance with the requirements of the applicable building code and other regulations. Refer to SECTION 01 41 00 "REGULATORY REQUIREMENTS" for further information.

1.04 SUBMITTALS

- A. Product Data:
 - 1. For equipment to be furnished and installed by Contractor, submit manufacturer's descriptive and technical data and illustrations, clearly marked to show specific products, materials, options, and compliance with requirements. Include manufacturer's printed installation instructions, requirements for substrate preparation, temperature and humidity; and other items required for the successful completion of the Work.
 - 2. For equipment to be furnished by the Owner for installation by the Contractor, submit manufacturer's printed Product Data; installation instructions; requirements for substrate preparation, temperature and humidity; and other items required for the successful completion of the Work. Obtain such Product Data from the Owner.
- B. Shop Drawings: Submit Shop Drawings showing layouts, sizes, general features, materials, sizes, and finishes; relationship to adjacent Work, and details of anchorage to supporting Work.

- C. Samples: Submit samples of items requiring Architect's color selection.
- D. Maintenance and Operating Data: For equipment to be furnished and installed by Contractor, furnish manufacturer's printed maintenance data and operating instructions to the Owner. Include the name, address, and telephone number of the nearest authorized service representative.

1.05 DELIVERY, STORAGE, AND HANDLING OF EQUIPMENT DESIGNATED TO BE INSTALLED BY THE CONTRACTOR

- A. Receive, store, and handle equipment in compliance with the applicable manufacturer's printed instructions.
- B. Handle equipment to prevent soiling and other damage.
- C. Store equipment in a clean, dry, protected location away from construction activities. Maintain storage within temperature and humidity ranges recommended in writing by the applicable manufacturer.
- D. Protect equipment from loss, damage, and deterioration during storage and handling.

1.06 COORDINATION

- A. Coordinate delivery of equipment with the Contractor's current construction schedule.
- B. Coordinate equipment with other Work including, but not limited to, space requirements, mounting heights, backing and other support requirements, and mechanical, plumbing, electrical, and control services.

PART 2 - PRODUCTS

2.01 HEALTHCARE EQUIPMENT SCHEDULE

- A. Healthcare equipment schedule is ~~indicated on the Drawings~~ included as Attachment A at the end of this SECTION.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify that conditions are satisfactory for installation of healthcare equipment.
- B. Verify that Owner-furnished equipment is satisfactory and ready for installation.
- C. Do not begin installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protect adjacent surfaces and finishes from damage during installation of equipment.
- B. Protect equipment from damage during field handling and installation.

3.03 EQUIPMENT TO BE FURNISHED AND INSTALLED BY THE OWNER

- A. Comply with requirements specified in SECTION 01 64 00 "OWNER-FURNISHED PRODUCTS" and other applicable SECTIONS of DIVISION 01 – GENERAL REQUIREMENTS.

3.04 EQUIPMENT TO BE FURNISHED BY THE OWNER FOR INSTALLATION BY THE CONTRACTOR

- A. Comply with requirements specified in SECTION 01 64 00 "OWNER-FURNISHED PRODUCTS" and other applicable SECTIONS of DIVISION 01 – GENERAL REQUIREMENTS.
- B. Install equipment as specified hereinafter in Article 3.05.

3.05 EQUIPMENT TO BE FURNISHED AND INSTALLED BY THE CONTRACTOR

- A. Install each equipment item in compliance with the applicable manufacturer's printed recommendations and instructions, accepted Shop Drawings, as indicated, and as specified.
- B. Set items securely in place, rigidly or flexibly mounted as required.
- C. Securely attach equipment to supporting construction. Where equipment is required to be welded to embeds or similar installed supports, welding quality shall comply with applicable specifications specified in SECTION 05 50 00 "METAL FABRICATIONS" and when exposed in the completed Work, shall be smooth, flush, and imperceptible.
- D. Make electrical, mechanical, plumbing, and control connections as indicated and required. Refer to Specification DIVISIONS 21 through 28 for further information.
- E. Clean equipment in compliance with the applicable manufacturer's printed recommendations without causing damage.
- F. Touch-up and restore damaged and defaced components and finishes in a manner that damage and repairs are not evident. Remove components that cannot be satisfactorily repaired and provide new acceptable Work.
- G. Test and adjust operation of equipment in the presence of the Owner, Architect, and manufacturer's authorized representative to ensure proper start-up and operation.
- H. Correct defects or replace and retest as required. Repairs, replacement, and retesting shall be made at no additional cost to the Owner.

3.06 PROTECTION

- A. Protect healthcare equipment from damage and deterioration until time of completion and acceptance by the Owner. Comply with recommendations of the applicable manufacturer.
- B. Do not allow construction activity or traffic near equipment without adequate protection.

END OF SECTION

Attachment A: Healthcare Equipment Schedule.

ATTACHMENT A
HEALTHCARE EQUIPMENT SCHEDULE

Equip ID	Equipment Name	Equipment Manufacturer and Model Info			Furnished By	Installed By	Position	Size				OSHPD		HVAC Connection	Plumbing Connection	Electrical Info						Data	Equip ID			
		Manufacturer	Model	Model Part				Width (inches)	Depth (inches)	Height (inches)	Weight (lbs.)	Approval	OPA #			Volts	~	Hz	Phase	Amps	Watts					
ABLAT01	Rotary Coronary Artery Ablator	Boston Scientific	Rotablator Console 22020-029	(form. by SciMed / Heart Tech)	O	O	Portable	12	13.3	7	25	Not Applicable				115	AC	60	Single	2 max	70		D	ABLAT01		
ALLOI11	24-Port 100-MB Switched Hubs, Fiber	(Manufacturer Not Identified)			O	O						Not Applicable											D	ALLOI11		
ALLOW01	Stainless Cabinet Enclosure	MDT Biologic Company			O	C	Maj Inst																	ALLOW01		
ANACO16	Automated Coagulation Analyzer	Sysmex Corp. of America	CA-1500		O	O	Counter	31.2	20	20	171.6	Not Applicable				117	AC	60	Single		720 VA		R	ANACO16		
ANACO20	Platelet Function Analyzer	Dade Behring, Inc./Siemens	PFA-100	B4170-00	O	O	Counter	9	15.1	14.2	24	Not Applicable				115	AC	60	Single	1.5	110		D	ANACO20		
ANACO30	Automated Coagulation Analyzer	Beckman Coulter Instruments	ACL TOP 500 CTS		O	O	Counter	43	35	29	312	Not Applicable			Y	120	AC	60	Single	10	1150 VA		M	ANACO30		
ANACO30A	17" Flat Panel Monitor with Touch Screen	Beckman Coulter Instruments	Monitor		O	O	Counter	14	3	17		Not Applicable				120	AC	60	Single	1.8			V	ANACO30A		
ANACO30B	Control Module (CPU) for ACL TOP 500 CTS	Beckman Coulter Instruments	CPU		O	O	Counter	7.5	19	17.5	37	Not Applicable				120	AC	60	Single	3.5	690 VA		V	ANACO30B		
ANACO30C	Cart for ACL TOP 500 CTS	Beckman Coulter Instruments	Cart		O	O	FloorStd	60	30	32	100	Not Applicable												ANACO30C		
ANAE113	Blood Gas Analyzer	Siemens Med. Sol.Diag.	RapidPoint 400		O	O	Counter	11.5	16	21.5	34	Not Applicable				120	AC	60	Single		150 VA		D	ANAE113		
ANAF001	Fetal Fibronectin Analyzer	Adeza Biomedical	TLIQ-01202		O	V	Counter	6.9	8.9	3	1.2	Not Applicable				120	AC	60	Single		16		D	ANAF001		
ANAFF01A	Printer for Fetal Fibronectin Analyzer	Adeza Biomedical	TLIQ		O	V	Counter	4.5	7	6		Not Applicable											V	ANAFF01A		
ANALB51	Blood Culture Analyzer- Double-Stacked	Becton Dickinson Microbiology	Bactec FX	441385 (Top) & 441386 (Bottom)	O	V	FloorStd	24.5	34.3	78.3	994	Pre-Approved	OPA-1810			120	AC	60	Single	7.0			D	ANALB51		
ANALM04	Automated Microbiology Analyzer	Dade Behring, Inc./Siemens			O	O	Counter	38	29	28	375	Not Applicable		Y		115	AC	60	Single	10			D	ANALM04		
ANALM30	Microbial Identification System	Becton Dickinson Microbiology	BD MicroProbe Processor	250100	O	O	Counter	11	9.5	6	18	Not Applicable				120	AC	60	Single	1			U	ANALM30		
ANALM30A	Lysis Block for MicroProbe	Becton Dickinson Microbiology	BD MicroProbe Lysis Block		O	O	Counter	4.5	3.5	1.5		Not Applicable											U	ANALM30A		
ANALM40	Automated Urine Specimen Processor	Dynacon Inc.	Innova		O	V	FloorStd	60	49.5	71	1100	Make Provision				120	AC	60	Single	8			D	ANALM40		
ANALM52	Colorimeter	bioMérieux Vitek, Inc.	S2-1210		O	O	Counter	3.5	6.5	3		Not Applicable				120	AC	60	Single	2.8				ANALM52		
ANAPR24	Chemistry/Immunoassay Analyzer	Roche Diagnostics	Cobas 6000		O	V	FloorStd	121	41	51	1947	Make Provision			Y								D	ANAPR24		
ANAPR24A	Control Unit Cart	Roche Diagnostics	Cobas 6000		O	V	FloorStd	32	32		165	Not Applicable				120	AC	60	Single		1298		D	ANAPR24A		
ANAU0R8	Urine Chemistry Analyzer	Bayer Corp. Diagnostics/Siemen	Clinitek 500		O	O	Counter	14.8	12.8	11.1	16.3	Not Applicable				120	AC	60	Single	0.6		72 VA max	D	ANAU0R8		
ANAU15	Automated Urinalysis System	IRIS International, Inc.	iQ200 Elite		O	V	Counter	21	24	22	100	Not Applicable			Y	120	AC	60	Single		150 VA		V	ANAU15		
ANAU15A	Automated Urine Chemistry Analyzer	IRIS International, Inc.	Arkray Aultion Max AX-4280		O	V	Counter	21	21	21	110	Not Applicable			Y	120	AC		Single		250		V	ANAU15A		
ANAU15B	Computer and Monitor for Urine Analyzer	IRIS International, Inc.	iQ200		O	V	Counter	8	19	17	111	Not Applicable				120	AC		Single		240		D	ANAU15B		
ANBGS01	Centrifuge-Blood Grouping Sys.	Ortho-Clinical Diagnostics	ID-Micro Typing System	MT-5150-60	O	O	Counter	13.5	19.3	5.8	14	Not Applicable				120	AC	60	Single	3 max.	330			ANBGS01		
ANBGS01B	Incubator-Blood Grouping Sys.	Ortho-Clinical Diagnostics	Micro Typing Systems DG-225	MTS9680	O	O	Counter	10.8	12.5	4.3	11	Not Applicable				110	AC	60	Single	1	110			ANBGS01B		
ANBNP02	BNP Analyzer	Biosite Incorporated	Triage Meter Plus		O	O	Counter	6.3	8.5	2.8	1.5	Not Applicable				120	AC	60	Single	0.5			D	ANBNP02		
ANEST81	Anesthesia Documentation Allowance	(Manufacturer Not Identified)	Typical of Dräger		O	O						Not Applicable											D	ANEST81		
ANEST82	Anesthesia Machine (2-Vap Config.)	GE Healthcare	Datex Aestiva 5 / 7900		O	O	FloorStd	29.5	32.7	53.4	300					120	AC	60	Single	10			R	ANEST82		
ANEST82A	10" Anesthesia Monitor	(Manufacturer Unknown)	To be determined		O	O	Accsry	12.4	2.9	10.4	7.5													ANEST82A		
ANGLU05	Blood Glucose Analysis System	Roche Diagnostics	AccuData GTS Advantage System	03000249001	O	O	Counter	11	8.8	4	5	Not Applicable											D	ANGLU05		
ANGLU07	Blood Glucose Analyzer	Roche Diagnostics	Accu-Chek Professional System		O	O	Portable	3.8	1.4	7.6		Not Applicable												ANGLU07		
ANHEM32	Automated Hematology Analyzer	Siemens HC Diagnostics (Lab)	Advia 2120 with Autosampler		O	V	Cart-Mtd	55.5	26.8	33.8	425	Make Provision				120	AC	60	Single	6			D	ANHEM32		
ANLZB01	Automated Blood Bank Analyzer	Ortho-Clinical Diagnostics	ProVue	MTS213784	O	O	Cart-Mtd	39.4	23.6	36.5	191.8	Not Applicable				120	AC	60	Single		650		U	ANLZB01		
ANLZB02C	Uninterrupted Power Supply	ImmuCor, Inc.	Powerware 9120 700		O	O	FloorStd	6.2	16.2	9.6	29	Not Applicable				120	AC	60	Single		490		D	ANLZB02C		
ANLZP03	i-STAT Portable Chemistry Analyzer	i-STAT Corporation div Abbott	i-STAT 1 Analyzer	06F16-10	O	O	Portable	2.5	2.1	8.3	1.5	Not Applicable											D	ANLZP03		
ANLZP03A	Downloader/Recharger - Network	i-STAT Corporation div Abbott	Network Downloader/Recharger	06F23-46	O	O	Counter	3.5	6	2.5	0.5	Not Applicable				115	AC	60	Single	0.9			D	ANLZP03A		
ANLZP03B	Portable Printer for i-STAT	i-STAT Corporation div Abbott	Martel	06F23-91	O	O	Portable	5.3	5.1	2.5	1	Not Applicable				120	AC	60	Single				D	ANLZP03B		
ANLZP03C	Software for i-STAT	i-STAT Corporation div Abbott	i-STAT 1 version 5.0	06F23-60	O	O						Not Applicable												ANLZP03C		
ARTW001	Allowance- Artwork: Print	(Manufacturer Unknown)	see www.artprintcollection.com		O	O	Wall-Mtd	24	3	32	16	Not Applicable												ARTW001		
ARTW002	Allowance- Original Artwork	(Manufacturer Unknown)	Typical of Mark Thompson		O	O	Wall-Mtd					Not Applicable												ARTW002		
ASPIR12	Portable Aspirator	Allied Healthcare Products	Gomco 405 / 4005	01-12-0405 or 01-12-4005	O	O	Counter	12	9	12	14.5	Not Applicable				115	AC	60	Single		75			ASPIR12		
AUDIOI15	Allowance- Stereo System	(Manufacturer Unknown)	Satellite Radio, CD, iPod conn (to be determined)		O	O	Wall-Mtd				10.7	Not Applicable				120	AC	60	Single				M	AUDIOI15		
BALAN14	Two-Pan Beam Balance	Ohaus Corporation	Harvard Trip 1454-SD	(Thomas Scientific # 1368-D40)	O	O	Counter	14	8.5	10.5	5.5													BALAN14		
BALAN16	Pharmacy Prescription Balance	Fulcrum Inc.	Torbal DRX-3	formerly by Vertex Industries	O	O	Counter	11.8	6	8	11	Not Applicable													BALAN16	
BATHD04	Dri Bath Heater	Lab-Line-Barnstead/Thermolyne	16500	16525	O	O	Counter	11.8	9	3.5	9	Not Applicable				120	AC	60	Single	3.8	450			BATHD04		
BATHT03	Tissue Float Bath	Lab-Line-Barnstead/Thermolyne	26103		O	O	Counter	13.3	13.3	3.5	6.5	Not Applicable				120	AC	60	Single	2.5	300			BATHT03		
BATHT07	Tissue Flotation Bath	Baxter Healthcare	145800		O	O	Counter	15	13.5	3.3	15	Not Applicable				115	AC	60	Single		700			BATHT07		
BATHW07	Water Bath	Thermo Fisher Scientific	181	2827	O	O	Counter	8	9.5	9.5	12	Not Applicable				120	AC	60	Single	2.0	225			BATHW07		
BATHW14	Plasma Thawing Water Bath	Helmer Labs, Inc.	DH8		O	O	Counter	18.5	22	15.5	74	Not Applicable				115	AC	60	Single	10				BATHW14		
BATHW14A	Digital Thermometer	Helmer Labs, Inc.	DT1	500606-1	O	O	Accsry	3	3	4		Not Applicable												BATHW14A		
BATHW14B	Chamber Cover	Helmer Labs, Inc.	CT8	400276-1	O	O	Accsry			6		Not Applicable												BATHW14B		
BATHW17	Plasma/Red Cell Thawing Bath	Thermo Forma	2032		O	O	Counter	30.5	16.4	16.3	79	Not Applicable		Y		120	AC	60	Single	11				BATHW17		
BENWK22	Mobile Workbench with Drawers & Cabinets	Workplace Systems Inc.	R-04-151-02G Stainless St Top		O	O	FloorStd	84	50	37.4	850	Not Applicable												BENWK22		
BFLOW03	Blood Flow Detector, Handheld	Nicolet Biomedical Inc./Viasys	Pocket-Dop II	P580	O	O	Portable	2.5	1.2	6	0.6	Not Applicable				110	AC	60	Single		6.5			BFLOW03		
BLEND04	Commercial Blender	Sunbeam Oster	OSTERIZER POWERBLEND BLENDERS	4105-8 (PRICE PER EACH/4 PACK)	O	O	Counter	10.3	7.3	14.8	8.3	Not Applicable				120	AC	60	Single		400			BLEND04		
BOARD01	Allowance- Marker Board, 36" w x 24" h	(Manufacturer Unknown)		(based on Claridge S1882X3LCS)	O	C	Wall-Mtd	36	0.8	24	9	Not Applicable												BOARD01		
BOARD02	Allowance- Tack/MarkerBoard, 48" w x 48" h	(Manufacturer Unknown)		(based on Claridge LCS5044)	O	C	Wall-Mtd	48	1	48	32	Make Provision												BOARD02		
BOARD03	Allowance- Tackboard, 48" w x 36" h	(Manufacturer Unknown)		(based on Claridge 751F)	O	C	Wall-Mtd	48	1	36	24	Make Provision												BOARD03		
BOARD08	Visual Presentation Cabinet	(Manufacturer Unknown)		(based on Peter Pepper #CC)	O	C	Wall-Mtd	96	5	48	133	Make Provision												BOARD08		
BOARD19	Allowance- White Board	(Manufacturer Unknown)		(based on Claridge Products)	O	C	Wall-Mtd	24	2	36	36	Make Provision												BOARD19		
BOARD22	Markerboard 60" x 36"	Quartet Manufacturing Company	SS35		O	C	Wall-Mtd	60		36		Make Provision												BOARD22		
BOARM34	Magnetic Marker Board, 34" w x 23" h	Quartet Manufacturing Company	QRTM3423	Quartet Matrix	O	C	Wall-Mtd	34	1	23	9	Not Applicable												BOARM34		
BOOMG54	Gas Services / Utility Boom	Berchold Corporation	Teletom 520 Series	TS-52C-0	O	V	Ceiling				801			Y		120	AC	60	Single	8.3			M	BOOMG54		
BOOMG54A	Vendor Installation of Boom	Berchold Corporation	Installation of TELETOM 520	89-000-0004	O	V	Maj Inst																	BOOMG54A		
BOOMG58	Gas Services / Equipment Boom	Berchold Corporation	Teletom 700 Series	TS-723-1	O	V	Ceiling				801	Pre-Approved	OPA-0158	Y		120	AC	60	Single	8.3			M	BOOMG58		
BOOMG58Z	Vendor Installation of Boom	Berchold Corporation	Teletom 700 Series	89-000-0004	O	V	Ceiling					Compliance												BOOMG58Z		
BUCKO1	Kick Bucket, 12.5 Quart	Blickman Health Industries	Lenox 7766SS	0817766000	O	O	FloorStd	14.5	14.5	12.5	12	Not Applicable												BUCKO1		
BUCKM03	Stainless Steel Mop Bucket, 8 Gallon	Geerpres Inc.	2223	Stainless Steel Round Bucket	O	O	FloorStd	17	17	17	16	Not Applicable												BUCKM03		
BUCKS04	Sponge Bucket	Pedigo	P-1025-SS		O	O	FloorStd	16.3	16.3	8	11	Not Applicable												BUCKS04		
CABBE09	Supply Cabinet	Custom Comfort																								

ATTACHMENT A
HEALTHCARE EQUIPMENT SCHEDULE

Equip ID	Equipment Name	Manufacturer	Model	Model Part	Furnished By	Installed By	Position	Width (inches)	Depth (inches)	Height (inches)	Weight (lbs.)	Approval	OPA #	HVAC Connection	Plumbing Connection	Volts	~	Hz	Phase	Amps	Watts	Data	Equip ID		
CARTC39	Emergency Crash Cart	InterMetro Industries Corp.	MetroFlex High Profile MFH	(specify accessories)	O	O	FloorStd	34	22	41	89	Not Applicable											CARTC39		
CARTC39A	Accessories for Crash Cart	InterMetro Industries Corp.	MetroFlex (cart accessories)		O	O	Accssry					Not Applicable											CARTC39A		
CARTE40	Mobile Equipment Cart	Patterson (Sammons Preston)	Z Cart/Laser Cart/Equip. Cart	561010	O	O	FloorStd	19	17	29	30	Not Applicable											CARTE40		
CARTF04	Basket/File Cart	W.A. Charnstrom	M106		O	O	FloorStd	21.5	40	36.8	54	Not Applicable											CARTF04		
CARTN15	Notebook/Laptop Computer Cart	Stinger Industries	Levitating, Laptop - Compact	6020	O	O	FloorStd	17	17	56.5		Not Applicable					120	AC	60	Single			CARTN15		
CARTP03	Modular Procedure "L" Cart	Herman Miller for Healthcare	CO212FF L Cart		O	O	FloorStd	23	22.3	36		Not Applicable											CARTP03		
CARTP25	Pyxis Anesthesia System	Pyxis Corporation/Carefusion	Pyxis Anesthesia System		O	O	FloorStd	33	26.5	39.5	399	Not Applicable					120	AC	60	Single	0.9		D	CARTP25	
CARTP42	Full-Height Procedure/Supply Cart	Stanley InnerSpace	4200FC + accessories		O	O	FloorStd	38	27	80	140												CARTP42		
CARTP48	5-Drawer Mini Procedure Cart	Armstrong Medical Industries	Std Mini Cart AMC-1- (color)	A-Smart Cart System	O	O	FloorStd	21.5	20.6	34	103	Not Applicable											CARTP48		
CARTP48A	Allowance: Tilt Bin Organizers for Cart	Armstrong Medical Industries	ATB- X (choose size/qty.)		O	O	Accssry					Not Applicable											CARTP48A		
CARTP50	Half-Height Procedure/Supply Cart	Stanley InnerSpace	Half Cart	4300HC	O	O	FloorStd	38	27	42	145												CARTP50		
CARTP51	Double-Wide Procedure/Supply Cart	InterMetro Industries Corp.	Starsys	SXDG54	O	O	FloorStd	42	27	43		Not Applicable											CARTP51		
CARTS03	Surgical Case Cart, Upright	Pedigo	CDS-233-C	End "C" adds shelves auto	O	O	FloorStd	28.6	28.6	56	155	Not Applicable											CARTS03		
CARTS20	Suture Cart	InterMetro Industries Corp.	DC35EC		O	O	FloorStd	36	18	60	98	Make Provision											CARTS20		
CARTS23	Closed Surgical Case Cart	Suburban Surgical Company Inc.	"TOTE-AL" 105494-00		O	O	FloorStd	33.8	27.4	39.4		Not Applicable											CARTS23		
CARTS23A	Solid Roll-Out Shelf for Case Cart	Suburban Surgical Company Inc.	220341-00		O	O	FloorStd					Not Applicable											CARTS23A		
CARTS23B	Wire Roll-Out Shelf for Case Cart	Suburban Surgical Company Inc.	220331-00		O	O	FloorStd					Not Applicable											CARTS23B		
CARTT01	Fiberglass Waste Truck	McClure Industries Inc.	TC-35FL	Sani-Trux	O	O	FloorStd	54	31	47	1000	Not Applicable											CARTT01		
CARTU01	Stainless Steel Utility Cart	Lakeside Manufacturing Inc.	411		O	O	FloorStd	27.7	16.8	33.4	42	Not Applicable											CARTU01		
CARTU03	Light-Duty SS Utility Cart	Lakeside Manufacturing Inc.	311		O	O	FloorStd	27.5	16.3	32.2	29	Not Applicable											CARTU03		
CARTU05	Molded 3-Shelf Utility Cart	Rubbermaid Products	3424-88 Utility Cart		O	O	FloorStd	33.7	18.7	37.8	27.5	Not Applicable											CARTU05		
CARTU10	Utility Cart, Stainless Steel	(Manufacturer Unknown)			O	O	FloorStd	30	18	32.5		Not Applicable											CARTU10		
CARTU17	Three-Shelf Utility Cart	InterMetro Industries Corp.	BC2636-3D		O	O	Portable	38.8	27	41.5	46.5	Not Applicable											CARTU17		
CARTU35	Small Plastic Utility Cart	Rubbermaid Products	4500-88		O	O	FloorStd	34.2	17.4	32.6	31	Not Applicable											CARTU35		
CARTU74	Three-Tier Plastic Utility Cart	Rubbermaid Products	9T65-71	086876173802	O	O	FloorStd	16.3	31.5	36	26.5	Not Applicable											CARTU74		
CASEP09	Pharmacy Department Casework	See Section 12 35 55					Maj Inst					Not Applicable											CASEP09		
CENCY05	Cytology Centrifuge	Thermo Electron (Shandon)	Cytospin 4 A78300002		O	O	Counter	16	24.5	9.5	26.5	Not Applicable					120	AC	60	Single		150VA		CENCY05	
CENTC09	Immunohematology Centrifuge	Baxter Scientific Products Div.	Dade Immufuge II		O	O	Counter	10	12	9	17	Not Applicable					120	AC	60	Single	3			CENTC09	
CENTC18	Countertop Centrifuge	VWR Scientific	Heraeus Megafuge 1.0	75003491 (VWR # 20300-016)	O	O	Counter	18.1	20.5	15.3	121	Not Applicable					120	AC	60	Single	6	1000		CENTC18	
CENTC20	Small Countertop Centrifuge	StatSpin Inc., An Iris Company	StatSpin MP	SSMP	O	O	Counter	6.7	6.7	5.3	5.5	Not Applicable					115	AC	60	Single	1.5	35		CENTC20	
CENTC40	Countertop Centrifuge	Fisher Scientific	05-101-7	Thermo Scientific # 004260F	O	O	Counter	14	16	11	24.2	Not Applicable					120	AC	60	Single	1.5			CENTC40	
CENTM23	Micro Centrifuge	Cardinal Health/Carefusion	StatSpin Express 3, SSX3	B8900-85	O	O	Counter	10.5	10	7	8.8	Not Applicable					100	AC	60	Single	3			CENTM23	
CENTR09	Refrigerated Countertop Centrifuge	Beckman Coulter Instruments	Allegra X-22R	392187	O	O	Counter	18.1	27.8	14.6	172						120	AC	60	Single	10.5			CENTR09	
CENTR11	Refrigerated Countertop Centrifuge	Heraeus Instruments (Kendro)	Multifuge 3 S-R	75004371	O	O	Counter	28.9	26.2	14.3	288	Not Applicable					230	AC	60	Single		1550		CENTR11	
CENTR52	Countertop Centrifuge	The Drucker Company	853VES	Horizon Plasmafuge-12	O	O	Counter	12.5	15.5	8.5	30	Not Applicable					115	AC	60	Single		200		CENTR52	
CENTR56	Countertop Centrifuge	Thermo Fisher Scientific	Multifuge 1 S	75004315	O	O	Counter	19.7	24.2	14.4	203	Not Applicable					120	AC	60	Single		1200		CENTR56	
CENTR59	Countertop Centrifuge	The Drucker Company	842VES	Horizon Plasmafuge-6	O	O	Counter	11	13.5	8	23						115	AC	60	Single		200		CENTR59	
CENTU01	Ultracentrifuge	Beckman Coulter Inc.	Airfuge CLS Ultracentrifuge	362781-03	O	O	Counter	11	15	8	23	Not Applicable					120	AC	60	Single	1	120		CENTU01	
CHAI01	Anesthesia Chair w/Arms, Non-Conductive	Armstrong Medical Industries	Ergonomic Chair AC-985A	(Biofit Chair)	O	O	FloorStd	23	23	50	52													CHAI01	
CHAI01	Allowance- Dining Chair	(Manufacturer Unknown)		(Based on Armless Stack Type)	O	O	FloorStd	24	23	36		Not Applicable												CHAI01	
CHAI02	Phlebotomy Chair	Custom Comfort Medtek	1201-LAH	(old NP1201-LAH)	O	O	FloorStd	35	23	34	95	Not Applicable												CHAI02	
CHAI04	Phlebotomy Chair	Custom Comfort Medtek	1201-LU	(old NP1201-LU)	O	O	FloorStd	35	24	36	85	Not Applicable												CHAI04	
CHAI40	Wide Phlebotomy Chair	Custom Comfort Medtek	Blood Draw Chair	NP 1201-LXL/XT	O	O	FloorStd	44	29	41	110	Not Applicable												CHAI40	
CHAI02	Allowance- Task Chair w/ Arms	(Manufacturer Unknown)		(based on Steelcase Criterion)	O	O	FloorStd	27.5	22.5	34	37	Not Applicable												CHAI02	
CHAI03	Allowance- Armless Task Chair	(Manufacturer Unknown)			O	O	FloorStd	25.5	27.5	34	37	Not Applicable												CHAI03	
CHAI06	Allowance- Ergonomic High Task Chair	(Manufacturer Unknown)		(based on Steelcase Leap)	O	O	FloorStd	27	24.8	41	37	Not Applicable												CHAI06	
CHAI11	Allowance- Lobby/Lounge Chair	(Manufacturer Unknown)			O	O	FloorStd	24	22	35	37	Not Applicable												CHAI11	
CHAI83	Visitor Chair with Arms	Hill-Rom Company Inc.	Classic Visitor Chair	VIS 200	O	O	FloorStd	21	21	32	37	Not Applicable												CHAI83	
CHSID01	Allowance- Side Chair	(Manufacturer Unknown)		(Nemschoff or Versteel = typ.)	O	O	FloorStd	23	23	32	15	Not Applicable												CHSID01	
CLOC006	Wireless GPS Analog Wall Clock	Primex Wireless Inc.	14155		O	O	Wall-Mtd	12.5	2	12.5		Not Applicable											W	CLOC006	
CLOC006A	Transmitter for GPS Wireless Clock Sys	Primex Wireless Inc.	14000 Transmitter w/GPS Recvr		O	V	Counter	17	12	1.9	7.8	Not Applicable					120	AC	60	Single	0.4		W	CLOC006A	
CLOC006B	Repeater for GPS Wireless Clock System	Primex Wireless Inc.	14006 Satellite Transmitter	with Receiver Switch	O	V	Counter	17	12	1.9	7.8						120	AC	60	Single	0.4		W	CLOC006B	
CLOC006D	Digital Event Timer	Primex Wireless Inc.	14203E		O	O	Wall-Mtd	23.3	3	8	6.5	Not Applicable					120	AC	60	Single	150 mA		W	CLOC006D	
CLOC073	Time System Badge Terminal	Kronos	4500 Badge Terminal		O	O	Wall-Mtd	10.8	4	11.8	5	Not Applicable					115	AC	60	Single	1.5		D	CLOC073	
COFFE10	Coffeemaker, Pour-Over 2-Plate	Bunn-O-Matic Corporation	Pour-OMatic VPR	VPRN (=NSF Approved)	O	O	Counter	16	8	20	29			Y			120	AC	60	Single	14	1575		COFFE10	
COFFE15	Coffeemaker, Plumbed-In	Bloomfield Industries	Integrity 9012		O	C	Counter	8.6	18	18.8	32	Not Applicable			Y		120	AC	60	Single	15	1800		COFFE15	
COFFE15A	Glass Decanters, Black Handle	Bloomfield Industries	89_		O	O	Portable					Not Applicable												COFFE15A	
COFFE15B	Glass Decanters, Orange Handle	Bloomfield Industries	89_		O	O	Portable					Not Applicable												COFFE15B	
CONIV20A	Cylinder Tank, "H" Size	(Manufacturer Unknown)			O	O	Counter					Not Applicable												CONIV20A	
CONIV37	Syringe Infusion Pump	Baxter Healthcare-IV Sys. Div.	Bard 300XL Mini-Infuser	2M8171	O	O	Portable	4.5	1.6	8.5	2	Not Applicable												CONIV37	
CONIV48	Three-Channel Infusion Pump	Alaris Medical sub. Cardinal	MedSystem III DLE		O	O	Portable	6	2.1	7.9	5.1	Not Applicable					120	AC	60	Single		6		CONIV48	
CONT116	Allowance- Neuro Surg Inst Containers	Sterion Inc.	131050;132050;133050;134050	131050;132050;133050;134050	O	O						Not Applicable												CONT116	
COOLW05	Hot and Cold Water Cooler	Oasis Corporation	B1SRHS		O	C	FloorStd	12.6	12.6	54	33	Not Applicable					115	AC	60	Single	5.5			COOLW05	
COPIE12	Copier	Savin Corporation	9210		O	V	FloorStd	44	23	42	163	Not Applicable			Y		120	AC	60	Single	15	1200		COPIE12	
COPIE35	Copier	Savin Corporation	9022		O	O	FloorStd	48	24	41	141	Not Applicable					115	AC	60	Single	>15			COPIE35	
COPIF51	Copier, 25000 Copies/Mo.	Sharp Electronics Corporation	AR-275		O	O	Counter	25.5	23	25.5	92	Not Applicable			Y		120	AC	60	Single	12	1500	P	COPIF51	
COPIF66	Floorstanding Copier, 120,000 copies/mon	Toshiba Copiers	E-STUDIO 352		O	O	FloorStd	26	29.8	46.5	270.1	Not Applicable					115	AC	60	Single	15	1500 max	D	COPIF66	
CREDT01A	Receipt Printer	(Manufacturer Unknown)	typical of Epson TM-T88IV		O	V	Counter	5.7	7.7	5.8		Not Applicable					24	DC		Single	1.7		M	CREDT01A	
CREDT03	Credit Card Verification - POS	Hypercom Corporation	T7 Plus		O	O	Counter	5.2	10	2.5	1.5	Not Applicable					120	AC	60	Single			M	CREDT03	
CRYOS09	Cryostat with Microtome	Leica Inc.	CM 1850		O	O	FloorStd	26.4	27.4	45.9	288.2	Not Applicable												D	CRYOS09
DEFIB51	Biphasic Defibrillator	Zoll Medical Corporation	M Series Biphasic w/Case	40310011100063010	O	O	Portable	10.3	8.2	6.8	25						120	AC	60	Single		220 VA	D	DEFIB51	
DEFIB51A	Multi-Function ECG Cable for Defib	Zoll Medical Corporation			O	O	Portable																D	DEFIB51A	
DEFIB51B	Single Battery Charger for Defibrillator	Zoll Medical Corporation	Base PowerCharger1x1	8050-0002-001	O	O	Portable	10.5	2.5	4	3.1						120	AC	60	Single		240 max.		DEFIB51B	
DEFIB51C	Internal Paddles for Defibrillator	Zoll Medical Corporation		8000-1040-01	O	O	Portable																	DEFIB51C	
DICTA10	Dictation/Transcription Unit	Lanier Worldwide-Voice Product	VoiceWriter 210		O	O	Counter	7.6	9.4	2.6	3.1	Not Applicable					120	AC	60						

ATTACHMENT A
HEALTHCARE EQUIPMENT SCHEDULE

Equip ID	Equipment Name	Manufacturer	Model	Model Part	Furnished By	Installed By	Position	Width (Inches)	Depth (Inches)	Height (Inches)	Weight (lbs.)	Approval	OPA #	HVAC Connection	Plumbing Connection	Volts	~	Hz	Phase	Amps	Watts	Data	Equip ID		
DOSEP01	Unit Dose Packaging System	Medical Packaging Products	Auto-Print II		O	O	Counter	36	15	14	65	Not Applicable				115	AC	60	Single	5.0			DOSEP01		
DRYER04	Glassware Dryer	Steris Corporation	Reliance 1024		O	V	FloorStd	36	32	80	650	Pre-Approved	OPA-1328			208	AC	60	Three	16			DRYER04		
DVDVC03	DVD / VCR Combination Deck	Sony Corporation of America	SLV-D370P		O	O	Counter	16.9	11.3	3.3	7.9	Not Applicable				120	AC	60	Single		25	M	DVDVC03		
DVDXX07	DVD Player	Sony Corporation of America	DVP-N577H		O	O	Counter	16.9	8.3	1.7	4.2	Not Applicable				120	AC	60	Single		12	M	DVDXX07		
DVDXZ50	Wall Mount for DVD/VCR Players	Peerless Industries Inc.	Multi-Mount PM600		O	C	Wall-Mtd	20	13.5	8.3	45	Make Provision										W	DVDXZ50		
ELSUC01	Cart for Electrosurgical Unit	Covidien (Valleylab)	UC8009		O	O	FloorStd	19.5	25.8	34.3	53	Not Applicable												ELSUC01	
ELSUG34	Electrosurgical Generator	Covidien	Force FX-C		O	O	Boom-Mtd	14	17	4.4	18	Not Applicable				120	AC	60	Single	7			D	ELSUG34	
ELSUG34B	Monopolar Footswitch for Electrosurg Gen	Covidien (Valleylab)	E6008		O	O	FloorStd				5	Not Applicable											D	ELSUG34B	
ELSUG34C	Bipolar Footswitch for Electrosurg Gen	Covidien (Valleylab)	E6009		O	O	FloorStd				5	Not Applicable											D	ELSUG34C	
EMBED08	Tissue Embedding Center	SAKURA Finetek U.S.A. Inc.	Tissue-Tek TEC 5	5100	O	O	Counter	35.6	25.3	14.8	105	Not Applicable				115	AC	60	Single	11				EMBED08	
EQUIP00	Room Contains No Equipment	(Manufacturer Unknown)			O	O						Not Applicable												EQUIP00	
ESRSY04	Erythrocyte Sedimentation Rate Analyzer	Clinical Data Inc.	Excyte 40	EX-10316	O	O	Counter	13	12.3	7.9	11	Not Applicable				100	AC	60	Single	0.75			D	ESRSY04	
EVACC01	Patient Evacuation Chair	Stryker Medical	6253		O	O	FloorStd	20.5	28	45	34	Make Provision												EVACC01	
EVACF15	Surgical Fluid Waste Docking Station	Stryker Instruments Corp.	Neptune 700-5	Docking Station	O	O	FloorStd	25	20	22	90	Make Provision			Y	120	AC	60	Single	3				EVACF15	
EVACF15A	Rover Waste Unit with Smoke Evacuation	Stryker Instruments Corp.	Neptune 700-1 Rover		O	O	FloorStd	18	25	60	290	Not Applicable				120	AC	60	Single	16				EVACF15A	
FACSI11	Facsimile Machine	Toshiba Copiers	TF-251		O	O	Counter	12.3	9.5	4		Not Applicable				120	AC	60	Single				U	FACSI11	
FACSM01	Facsimile Machine	Toshiba Copiers	TF861		O	O	Counter	25	21	15	61.7	Not Applicable		Y		115	AC	60	Single	7.7			D	FACSM01	
FACSM21	MultifunctionFacsimile Machine	Canon USA Inc.	Laser Class 710		O	O	Counter	19.7	19.7	18.2	51	Not Applicable				110	AC	60	Single		13		M	FACSM21	
FACSM45	Facsimile Machine	Toshiba America Consumer Prod.	e-Studio 170F		O	O	Counter	19.3	33.5	17.1	35.3	Not Applicable				110	AC	60	Single		1000 max		M	FACSM45	
FACSM46	Facsimile Machine	Toshiba America Consumer Prod.	DP85F		O	O	Counter	18.7	27.8	17.1	39.7	Not Applicable				120	AC	60	Single		620 max		M	FACSM46	
FILEC01	5-Drawer Vertical File Cabinet	(Manufacturer Unknown)			O	O	FloorStd	15	28.5	60	136	Make Provision												FILEC01	
FILEC05	2-Drawer Vertical File Cabinet	(Manufacturer Unknown)		(typ of Steelcase, Hon, etc.)	O	O	FloorStd	15	30	29.5														FILEC05	
FILEC17	4 Drawer Vertical File	The Hon /AllSteel Company	HON534Q		O	O	FloorStd	15	25	52	107	Not Applicable												FILEC17	
FILEL01	2-Drawer Lateral File Cabinet	(Manufacturer Unknown)		(typ. Steelcase/Universal File	O	O	FloorStd	36	19	27	190	Not Applicable												FILEL01	
FILEL05	5-Drawer Lateral File Cabinet	(Manufacturer Unknown)		Based on Steelcase 100 Series	O	O	FloorStd	36	18	63.6		Make Provision												FILEL05	
FILEL12	4-Drawer Lateral File Cabinet	The Hon /AllSteel Company	H684L		O	O	FloorStd	36	19.3	53.3	169	Not Applicable												FILEL12	
FLOWA09	Air Flowmeter with Adapter	Precision Medical Inc.	1MFA2005PTO (Ohmeda adapter)		O	O	Portable					Not Applicable												FLOWA09	
FLOWO30	Oxygen Flowmeter with Adapter	Precision Medical Inc.	1MFA1005PTO (Ohmeda adapter)		O	O	Portable					Not Applicable												FLOWO30	
FREBB02	Blood Bank Freezer	Helmer Labs, Inc.	i Series 125	IPF125-8	O	O	FloorStd	30.8	38.5	80	600	Make Provision				230	AC	60	Single	8 FLA			U	FREBB02	
FREBB02A	Anchor Bracket Kit	Helmer Labs, Inc.	400472-1		O	O	Accssry					Pending												FREBB02A	
FREEU07	Medical Grade Undercounter Freezer -20°C	Follett Corporation	FZR5		O	O	FloorStd	23.8	27.5	34.1	145	Not Applicable				115	AC	60	Single	8.0				FREEU07	
FREEU52	Upright Lab Freezer	Helmer Labs, Inc.	Horizon Series HLF120		O	O	FloorStd	30.8	32.5	80	455	Make Provision				208	AC	60	Single	6 FLA			U	FREEU52	
FREEU52A	Anchor Bracket Kit	Helmer Labs, Inc.	400472-1		O	O	Accssry					Pending												FREEU52A	
FREEZ65	Two-Door Pharmacy Freezer	Gem Scientific	2DF		O	O	FloorStd	62.3	34.3	82.5	900	Make Provision		Y		230	AC	60	Single	11			U	FREEZ65	
FREEZ65A	Temperature Chart Recorder	Gem Scientific	GTR		O	O						Not Applicable												FREEZ65A	
FREEZ65B	Alarm/Monitor	Gem Scientific	GMS Temp. Monitor		O	O						Not Applicable												FREEZ65B	
FREEZ65C	Remote Monitor/Battery Backup	Gem Scientific			O	O	Wall-Mtd					Not Applicable											M	FREEZ65C	
FREEZ90	Tissue Freezing Histobath 2	Thermo Electron (Shandon)	Histobath 2	2431030	O	O	Counter	19.3	13.5	14.8	55	Not Applicable				115	AC	60	Single	4.2				FREEZ90	
GLVBX02	Anaerobic Glove Chamber	Sheldon Manufacturing Inc.	Bactron II		O	O	Counter	62.5	32.5	29.5	690	Make Provision				120	AC	60	Single	9.17	1100			GLVBX02	
GLVBX02A	Floor Stand for Anaerobic Glove Box	Sheldon Manufacturing Inc.	STDII		O	O	FloorStd	61.5	30	31	180	Make Provision												GLVBX02A	
HAMPE25	18" Triangular Hamper with Lid	Pedigo	P-120-L		O	O	FloorStd	18	18	32	50	Not Applicable												HAMPE25	
HAMPE30	Linen Hamper without Lid	Centricare Corporation	3300D		O	O	FloorStd	18.5	20	33.5	50	Not Applicable												HAMPE30	
HAMPE48	18" Triangular SS Hamper Stand	Pedigo	P-1120-SS		O	O	FloorStd	18	18	32	50	Not Applicable												HAMPE48	
HEADF02	Stereotactic Headframe	Integra Radionics	CRW Functional Neurosurgery	System	O	O						Not Applicable												HEADF02	
HEADW75	Recessed Horizontal Headwall, Two Tier	Modular Services Company	Silhouette 8600 Semi-Recessed	Two-Tier	O	C	Wall-Mtd	109	1.2	28.1		Pre-Approved	OPA-1776		Y								D	HEADW75	
HEATB04	Heating Block	Barnstead International	Thermolyne Dri-Bath-17600	DB17615 Type 17600	O	O	Counter	8	9	4	2.5	Not Applicable				120	AC	60	Single	.63	75			HEATB04	
HEATB06	Heating Block	Lab-Line-Barnstead/Thermolyne	Lab-line 2093		O	O	Counter	12	11	8		Not Applicable				115	AC	60	Single	2	200			HEATB06	
HEATB10	Heating Block	Techne (Bibby Scientific US)	DB-3	1081400	O	O	Counter	10.2	11	4.1	13	Not Applicable				120	AC	60	Single		650			HEATB10	
HEATC02	Heater/Cooler	Sarns/Terumo	11160 Dual Cooler/Heater		O	O	FloorStd	15.5	24.5	27.5	75	Not Applicable		Y		110	AC	60	Single	12				HEATC02	
HOODA03	Fume Adsorber Workstation	Hacker Instruments Inc.	Down Draft Fume Extractor		O	O	Counter	25	19	16	48	Not Applicable				115	AC	60	Single	3				HOODA03	
HOODB46	3' Biological Safety Cabinet	The Baker Company	SterilGARD III Advance SG303		O	C	FloorStd	35.7	30.7	63.3	397	Pending	OPA-2240-07			115	AC	60	Single	9.0	426			HOODB46	
HOODB46B	Telescoping Stand for Biosafety Cabinet	The Baker Company			O	C	FloorStd	31.5	27.9	28.5	110	Not Applicable												HOODB46B	
HOODB51A	IV Bar for Biological Safety Cabinet	The Baker Company	IV Bar		O	O	FloorStd					Not Applicable												HOODB51A	
HOODB51B	UV Light for Biological Safety Cabinet	The Baker Company	UV Light		O	O	FloorStd					Not Applicable												HOODB51B	
HOODB51C	Optional Telescoping Stand for Hood	The Baker Company	Hood Stand		O	O	FloorStd				36.6	100	Not Applicable											HOODB51C	
HOODB60	4' Negative Pressure Barrier Isolator	NuAire	NU-NR797-400		O	C	FloorStd	50	32.5	51.8	700	Pending				115	AC	60	Single	6				HOODB60	
HOODB60A	Exhaust Canopy Transition	NuAire	NU-916-797		O	C	FloorStd																	HOODB60A	
HOODB71	4' Biological Safety Cabinet, Vert. Flow	The Baker Company	SterilchemGARD III Advance	SG403ATX	O	C	FloorStd	53.7	30.6	100.9	596	Pending	OPA-2240-07		Y	115	AC	60	Single	9	460			HOODB71	
HOODB75	Barrier Isolation Hood	NuAire	Pharmagard 797	NU-PR797-400	O	C	FloorStd	50	32.5	51.5	425	Pending				115	AC	60	Single	6				HOODB75	
HOODB75A	Motorized Base Stand for Isolation Hood	NuAire	Pharmagard 797		O	C	FloorStd	54.3	32.5	33	150	Not Applicable				120	AC	60	Single	6.0				HOODB75A	
HOODF12	Fume Hood- 36" w	Fisher Hamilton Inc	SafeAire 54LS86		O	C	Maj Inst	36	31.3	60.8	485	Make Provision				120	AC	60	Single		50			HOODF12	
HOODF12A	Allowance- Blower/Accessories	Fisher Hamilton Inc			O	C	Maj Inst		19.7	25.8	245	Not Applicable				115	AC	60	Single		754			HOODF12A	
HOODF50	Bench Top Vent. Hood	Kewaunee Scientific Corp.	Visionaire View 2010		O	O	Counter	25	25	30	40	Not Applicable												HOODF50	
HOODH07	Horizontal Laminar Flow Hood, 74" w	NuAire	NU-301-630 (AireGard 301)		O	O	FloorStd	74	32	72.8	430	Pre-Approved	OPA-0536			115	AC	60	Single	15				HOODH07	
HYPOH17	Patient Warming System	Arizant Healthcare	Bair Paws 850		O	O	Wall-Mtd	7.7	2.5	11	6.3					120	AC	60	Single	3.0	290 Peak			HYPOH17	
HYPOH18	Patient Warming Unit	Arizant Healthcare	Bair Hugger 750		O	O	FloorStd	10	13.5	12	15.5	Not Applicable				120	AC	60	Single	11.7				HYPOH18	
ICEDR01	Dry Ice Maker	Bel-Art Products	Frigimat	ScienceLab.com # 60-388780010	O	O	Counter	12	6.5	5	12	Not Applicable												ICEDR01	
ICEMA73	Icemaker with 90 lbs. Storage	Follett Corporation	110CT400A	Symphony 110 Series	O	C	Counter	24.5	27.9	52.8	290	No		Y		115	AC	60	Single		4000			ICEMA73	
IDBK01	Allowance- Bookcase	(Manufacturer Unknown)		(based on Hon 1870 Series)	O	O	FloorStd	36	12	72		Make Provision												IDBK01	
IDCHR05	Armless Task Chair	Chairs by Cooke, Inc.	A-3 (no arms)		O	O	FloorStd	24	24	35		Not Applicable												IDCHR05	
IDCHR24	Side Chair	Wieland	343121		O	O	FloorStd	23	22.3	31.5		Not Applicable												IDCHR24	
IDCHR55	Stackable Chair	Kimball International	Event Chair 095-411		O	O	FloorStd	20	21	31		Not Applicable												IDCHR55	
IDCHS15	Allowance- Conference Chair with Casters	Ki (Krueger International)	TGWAU Torsion on the Go!		O	O	FloorStd	23.5	24.3																

ATTACHMENT A
HEALTHCARE EQUIPMENT SCHEDULE

Equip ID	Equipment Name	Manufacturer	Model	Model Part	Furnished By	Installed By	Position	Width (Inches)	Depth (Inches)	Height (Inches)	Weight (lbs.)	Approval	OPA #	HVAC Connection	Plumbing Connection	Volts	~	Hz	Phase	Amps	Watts	Data	Equip ID	
INJEC11H	Injector Head Extension Cable	Medrad Inc.	Mark V Provis	KMA 950-S100 I	O	O						Not Applicable											INJEC11H	
INJEC11J	Remote Control Panel for Injector	Medrad Inc.	Mark V Provis		O	O		12	6	9.3	10.5	Not Applicable											INJEC11J	
INSTA03	Surgical Instrument Allowance	(Manufacturer Unknown)	(to be determined)		O	O	Portable					Not Applicable											INSTA03	
INSTT02	Large Instrument Table, 48" w x 24" d	Blickman Health Industries	Howard 7835SS (w/ Lower Shelf)	0117835000	O	O	FloorStd	48	24	34	130	Not Applicable											INSTT02	
INSTT03	Small Instrument Table, 30" w x 16" d	Blickman Health Industries	Howard 7829SS (w/ Lower Shelf)	0117829000	O	O	FloorStd	30	16	34	50	Not Applicable											INSTT03	
INSTT04	Large Instrument Table, 60" w x 24" d	Blickman Health Industries	Howard 7836SS (w/ Lower Shelf)	0117836000	O	O	FloorStd	60	24	35	200	Not Applicable											INSTT04	
INSTT27	Instrument Table, 60" w x 24" d	Pedigo	SG-95-SS		O	O	FloorStd	60	24	34													INSTT27	
LAMMA01	Magnification Lamp	Luxo Lamp Corporation	The Wave Plus 30" Reach: K-Arm	17846	O	O		9	6	30	11	Not Applicable				110	AC	60	Single	0.009	7		LAMMA01	
LAMMA01A	Edge Clamp for Magnification Lamp	Luxo Lamp Corporation	50001		O	O	Counter					Not Applicable											LAMMA01A	
LAMMA02	Magnification Lamp	Luxo Lamp Corporation	KFM-2/FE 3D	17253	O	O					37	Not Applicable				120	AC	60	Single		22		LAMMA02	
LARYN01	Intubation Laryngoscope Handle	Welch Allyn Inc.	"C" Size Handle	60813	O	O	Portable	1.1	1.1	6	0.4	Not Applicable											LARYN01	
LARYN01A	Fiberoptic Blades - Allowance	Welch Allyn Inc.			O	O						Not Applicable											LARYN01A	
LBGRS10	5' Grossing Station	Mopec Inc.	MB600		O	O	FloorStd	60	29	86.3	800	Make Provision				115	AC	60	Single	20			LBGRS10	
LBGRS10A	ALL Accessories for Grossing Station	Mopec Inc.	MB600		O	O	FloorStd					Not Applicable										U	LBGRS10A	
LBGRS10B	Seismic Anchor Kit	Mopec Inc.	SA100 for MB600		O	C	FloorStd																LBGRS10B	
LIGES04	Exam Spot Light, Pair	Skytron	Argos HA60AR-WC		O	C	Ceiling	16.5	16.5		25	Pre-Approved	OPA-1608			120	DC		Single	3	100 each		LIGES04	
LIGEX03	Gooseneck Exam Light	Philips Burton	Pearl Light	0183010CH	O	O	FloorStd				15	Not Applicable				120	AC	60	Single		60		LIGEX03	
LIGEX11A	Ceiling Mount	Philips Burton		0112022	O	O	Ceiling					Make Provision											LIGEX11A	
LIGHF01	Wall-Mounted Flashlight	Black & Decker	SPOT LITER		O	O	Wall-Mtd	5	6	9.5		Not Applicable											LIGHF01	
LIGMG02	Magnifier Light	Dazor Manufacturing Corp.	DMC-200 Circline Magnifier		O	O	Counter		42		15	Not Applicable				110	AC	60	Single	0.38			LIGMG02	
LIGSB14	Dual Surgical Light with Flat Panel	Berchtold Corporation	660/660/224 Dual 26" & FP Arm	CD-889-6021	O	V	Ceiling				311	Pre-Approved	OPA-0158			120	AC	60	Single		240 VA	M	LIGSB14	
LIGSB14B	In-Light Camera System	Berchtold Corporation	Chromovision HR 24 IR System	cc-245-0375	O	V	Accssry					Not Applicable				120	AC	60	Single			R	LIGSB14B	
LIGSB14C	Vendor Installation of Light	Berchtold Corporation	88-000-0004		O	V						Not Applicable											LIGSB14C	
LIGSB15	21" Surg. Light w/Flat Pan.Arm	Berchtold Corporation	D540 plus/224 Flat Panel Arm	CD-651-5371	O	V	Ceiling				270	Pre-Approved	OPA-0158			120	AC	60	Single		240VA		LIGSB15	
LIGSB15A	Wall Control Box for Surgical Light	Berchtold Corporation	Chromophare D540 Plus		O	V	Wall-Mtd	6.3	1.3	9.5		Not Applicable											LIGSB15A	
LIGSB15Z	Installation of Surgical Light	Berchtold Corporation	Installation		O	V	Maj Inst					Not Applicable											LIGSB15Z	
LIGSB23	Dual Surgical Lights with Dual FP Arms	Steris Corporation			O	V	Ceiling				287					120	AC	60	Single			V	LIGSB23	
LIGSB23D	Installation Add FP Arms	Steris Corporation	Installation FP Arms	SE126482	O	V																V	LIGSB23D	
LIGUV08	Handheld UV Lamp	UVP Inc.	Blak Ray UVL-56	95-0006-02	O	O	Counter	3.2	14.9	2.5	2	Not Applicable				115	AC	60	Single	1.8	6		LIGUV08	
MATAF03	Anti-Fatigue Matting, 60"x 36"	Cactus Mat Manufacturing Co.	Cushion Comfort C Style	Style 1075	O	O	FloorStd	60	36	0.5	15	Not Applicable											MATAF03	
MICRT12	Motorized Rotary Microtome	Microm (div. of Richard-Allan)	HM 355 S	905480	O	O	Counter	16.1	20.5	11	79.4	Not Applicable				115	AC	60	Single	1.6			MICRT12	
MICRT15	Rotary Microtome	Leica Inc.	RM2125	14045737988	O	O	Counter	11.6	18.5	15.7	64	Not Applicable											MICRT15	
MIXDF09	Chemical Proportioning Unit	Hydro Systems Company	TaskMizer Dual Select	48792	O	V	Wall-Mtd	11	6.8	18	4	Not Applicable			Y	Y							MIXDF09	
MIXLB01	Lab Mixer	VWR Scientific	S8220-1	(Replaced by #58799-945)	O	O	Counter	6	5	4	9	Not Applicable				115	AC	60	Single		72		MIXLB01	
MIXVI01	Activation Device for Definity Vial	Lantheus Medical Imaging	VIALMIX	515030-1201	O	O	Counter	7.7	7.7	6.3	8.3	Not Applicable				120	AC	60	Single	3	330 VA		MIXVI01	
MIXVO01	Vortex Mixer	Barnstead International	Maxi-Mix II, Type 37600	M37615	O	O	Counter	4.5	7	6	7	Not Applicable				120	AC	60	Single	.52	62		MIXVO01	
MIXWB07	Whole Blood Tube Mixer/Shaker	Barnstead International	Labquake	415110	O	O	Counter	18.5	4	6	4	Not Applicable				120	AC	60	Single	0.5			MIXWB07	
MONBG03	Blood Parameter Monitor	Terumo Medical Corporation	CDI 500A HCT		O	O	Counter	12.5	6	11	16.1					120	AC	60	Single	2		R	MONBG03	
MONBG03A	Calibrator	Terumo Medical Corporation	S40		O	O	Counter	8	8	12.5	8.4												MONBG03A	
MONEG04	OR/ICU EEG/EP/EMG Monitor	Axon Systems Inc.	EpochLite 8 channel		O	O	Counter	15.5	15.5	6	26	Not Applicable				115	AC	60	Single		300	D	MONEG04	
MONEG04A	System Cart for Monitor	Axon Systems Inc.	MCNW16		O	O	Counter	19	29	38	90	Not Applicable										D	MONEG04A	
MONHE07	Hemodynamic Monitoring System	GE Healthcare	HemoLab/Mac-Lab IT	INHW-AAAAAXQ-XXXX	O	V	Counter				45					110	AC	60	Single	6	600	M	MONHE07	
MONHE07A	Invasive Monitoring Server Rack	GE Healthcare	INW	INWSYS-AMX-XX-X	O	V	Counter	24	36	43	176					120	AC	60	Single			M	MONHE07A	
MONHE07B	Nurse Workstation Allowance	GE Healthcare	INWSYS-AXA-XX-X		O	V	Counter	27	29	29.5												D	MONHE07B	
MONHE07D	20" Flat Panel Monitor for Hemodynamic	GE Healthcare	PC-MN18-A		O	V	Counter	18	8	15	65					120	AC	60	Single			D	MONHE07D	
MONHE07E	Printer for Hemodynamic Monitoring	GE Healthcare	LaserJet	PC-PNLE-A(Ricoh AFICIOCL3000e)	O	V	Counter	16.5	21.1	15.6	68.3					120	AC	60	Single		1300	D	MONHE07E	
MONHE07F	Lg Control Desk Hemodynamic Monitoring	GE Healthcare			O	V	Counter	65	29.5	30	65											D	MONHE07F	
MONHE07G	Main Server for Hemodynamic Monitoring	GE Healthcare	Hemsw Dms	INS-AXXXAXA-XXXXXXX	O	V	Counter	17.5	26.5	3.4												D	MONHE07G	
MONIS77	Configured Portable/Bedside Monitor	GE Healthcare	Dash 4000 Pro		O	O	Counter	11.5	9.6	10.8	12.2					120	AC	60	Single	2	75	D	MONIS77	
MONIS77B	Wall Mount for GE Dash 4000 Monitor	GCX Corporation	WMM-0002-02		O	O	Counter	2.2	17.9	5													MONIS77B	
MONIS77D	CO2 Option for GE Dash 4000 Monitor	GE Healthcare			O	O	Counter																MONIS77D	
MONIS91	Bedside Physiological Monitor	Philips Med Sys North America	IntelliVue MP30	M8002A 862135	O	V		13.6	9	10.8	13.2	Not Applicable				120	AC	60	Single	1.8 max	100 max	D	MONIS91	
MONIS91A	Wall Mount for Physiological Monitor	Philips Med Sys North America	GCX MP Variable Hgt Mount	989803137491	O	C	Wall-Mtd					Pre-Approved	OPA-0697										MONIS91A	
MONIV78	42" Flat Panel Plasma Display	Fujitsu	P42HCA51WH (old P42HCA11WH)		O	C	Wall-Mtd	40.7	3.3	25.2	65	Not Applicable				120	AC	60	Single	4.4		V	MONIV78	
MONIW01	52" Professional LCD Monitor	Sharp Electronics Corporation	PN-525U		O	O	Wall-Mtd	49.4	5.9	29.2	97	Not Applicable				120	AC	60	Single		325	D	MONIW01	
MONMO02	Articulating Mount for Monitor	GCX Corporation	VHM Var. Height Suspension Mt.	AG-0018-29 (for MP60/70)	O	C	Wall-Mtd	14.8	10.8			Pre-Approved	OPA-0697										MONMO02	
MONOX09	Whole Blood Oximeter	ITC	AVOXimeter 1000E		O	O	Counter	10	8	3.8	4					120	AC	60	Single		15	R	MONOX09	
MOUNT03	Flat Panel Wall Mount (Up to 26")	Chief Manufacturing Inc.	FWD-110 Dual Arm Wall Mount		C	C	Wall-Mtd	13	15.9	12.2	8	Not Applicable											MOUNT03	
OSMOM05	Micro-Osmometer	Advanced Instruments Inc.	Micro-Osmometer 3300		O	O	Counter	10.5	14	15	14	Not Applicable				110	AC	60	Single	.8	100	D	OSMOM05	
OVEND07	Drying Oven	Lindberg / Blue M	OV-8A		O	O	Counter	13	16	18		Not Applicable				120	AC	60	Single		525		OVEND07	
OVENM37	Commercial Microwave Oven	Amana (div of Maytag Corp)	RCS10MP	UPC 042159050697	O	O	Counter	21.8	19.8	14.3	50	Not Applicable				120	AC	60	Single	13.8	1700	I	OVENM37	
OVENM48	Compact Microwave Oven	Best Buy Corp./Commercial	GE Model JES735BF		O	O	Counter	19	13.5	11	25	Not Applicable				120	AC	60	Single		700		OVENM48	
OVENU03	Lab Utility Oven	Boekel Scientific	107800		O	O	Counter	13.8	13.5	16.5	25	Not Applicable				120	AC	60	Single		660		OVENU03	
OVENU16	Lab Utility Oven	Thermo Fisher Scientific	Precision 3051	PR305165-G	O	O	Counter	25.8	23.5	39.3	140	Not Applicable				120	AC	60	Single	11	1320		OVENU16	
PACEE11	Dual-Chamber External Pacemaker	Medtronic Inc.	5388	Item # 198092001	O	O	Portable	3.2	1.4	8.3	1.2	Not Applicable											PACEE11	
PACEE12	External Demand Pacemaker	Medtronic Inc.	5348		O	O	Portable	2.4	1.6	7.4	0.7	Not Applicable											PACEE12	
PATTR06	Patient Flow Tracking System License	Care Logistics LLC	Additional License Allowance	(components TBD)	O	O	Wall-Mtd					Not Applicable										D	PATTR06	
PATTR50	Patient Tracking 42" Flat Panel	(Manufacturer Unknown)			O	O	Wall-Mtd	40.2	3.5	24	69.4	Make Provision				120	AC	60	Single	0.9	337	V	PATTR50	
PHLEB80	Wheelchair Phlebotomy Arm	Custom Comfort Medtek	BB5905		O	C	Wall-Mtd	26	24			Not Applicable											PHLEB80	
PHMET07	pH Benchtop Meter	Thermo Fisher Scientific	Orion 2 Star	1111000	O	O	Counter	6.7	8.8	3.7	2	Not Applicable				110	AC	60	Single	0.5		R	PHMET07	
PHONE01	Telephone	(Manufacturer Unknown)			O	V		6.7	8.8	3.9	1.5	Not Applicable										P	PHONE01	
PHONE01A	Wall Mount for Telephone	(Manufacturer Unknown)			O	V	Wall-Mtd				0.5	Not Applicable										P	PHONE01A	
PLANT01	Allowance- Planter	(Manufacturer Unknown)			O	O	FloorStd	26	26	22	20	Not Applicable											PLANT01	
PLATE01	Hot Plate	Fisher Scientific	Ceramic Top Hotplate	11-501-7H	O	O	Counter	9	9.6	5	5	Not Applicable			Y	120	AC	60	Single	9.2	1100		PLATE01	
POWRS11	Uninterruptible Power Source	American Power Conversion	400																					

ATTACHMENT A
HEALTHCARE EQUIPMENT SCHEDULE

Equip ID	Equipment Name	Manufacturer	Model	Model Part	Furnished By	Installed By	Position	Width (Inches)	Depth (Inches)	Height (Inches)	Weight (lbs.)	Approval	OPA #	HVAC Connection	Plumbing Connection	Volts	~	Hz	Phase	Amps	Watts	Data	Equip ID	
PRINS03	Lab Slide Printer & Unload Station	Leica Inc.	IP S		O	O	Counter	21.6	21.7	25.8	94.9	Not Applicable				120	AC	60	Single		700 VA	D	PRINS03	
PRINS04	Lab Cassette Printer & Unload Station	Leica Inc.	IP C		O	O	Counter	21.6	21.7	25.8	97.1	Not Applicable				120	AC	60	Single		700 VA	D	PRINS04	
PRINT88	Dot Matrix Printer	Okidata	Microline 520		O	O	Counter	17	15	6.5	17.6					120	AC	60	Single		70 VA	D	PRINT88	
PRINU03	Dot Matrix Printer	Okidata	MICROLINE 320 Turbo, ML320T	62411601	O	O	Counter	15.7	13.6	4.6	15.4					120	AC	60	Single		100 maximum	D	PRINU03	
PRINU52	Personal Laser Printer	Hewlett-Packard Business Sys.	LaserJet 1100 Series		O	O	Counter	14.5	12.8	14.9	16	Not Applicable				120	AC	60	Single		200		PRINU52	
PRINU71	Inkjet Color Printer	Hewlett-Packard Business Sys.	DeskJet 6122	C8954B	O	O	Counter	17.9	14.9	7.3	13.5	Not Applicable				120	AC	60	Single		35	D	PRINU71	
PRINU74	Dot Matrix Printer	AMT Datasouth Corporation	AMT ACCEL-6310 d		O	O	Counter	19	16.8	11.4	48	Not Applicable				110	AC	60	Single	2.5		V	PRINU74	
PRINU83	Desktop Laser Printer	Hewlett-Packard Business Sys.	LaserJet 4100n		O	O	Counter	15.4	19.9	13.6	45.7	Not Applicable				120	AC	60	Single	4		D	PRINU83	
PRINV34	Laser Printer, Black & White	Hewlett-Packard Business Sys.	HP LaserJet 4350n	Q5407A	O	O	Counter	16.5	17.8	14.8	45	Not Applicable				120	AC	60	Single		790	V	PRINV34	
PRINV38	Laserjet Printer	Hewlett-Packard Business Sys.	LaserJet 4250n	Q5401A	O	O	Counter	16.5	17.8	14.8	45	Not Applicable			Y	110	AC	60	Single	10	675	V	PRINV38	
PRINV39	Laserjet Printer	Hewlett-Packard Business Sys.	LaserJet 2430tn	Q5961A	O	O	Counter	16.7	15.7	15.7	48.5	Not Applicable				110	AC	60	Single		325	V	PRINV39	
PRINV40	Color Laser Printer	Hewlett-Packard Business Sys.	LaserJet 2600n	Q6455A	O	O	Counter	16.1	17.8	14.6	40.5	Not Applicable				110	AC	60	Single		190	D	PRINV40	
PRINV71	Dot Matrix Printer	Epson America, Inc.	DFX-9000	C11C605001	O	O	Counter	27.6	14.9	14.3	75	Not Applicable				120	AC	60	Single		200	D	PRINV71	
PRINV88	Black & White Laser Printer	Xerox Business Systems	Phaser 3500		O	O	Counter	15.6	18.6	13.9	38	Not Applicable				120	AC	60	Single	6.5		D	PRINV88	
PRINV91	Monochrome Laser Printer	Lexmark, An IBM Alliance Co.	E250DN		O	O	Counter	15.6	14.1	10.2	25	Not Applicable				120	AC	60	Single		500	D	PRINV91	
PRINX14	Laser Printer	Lexmark, An IBM Alliance Co.	E323		O	O	Cart-Mtd	15.4	14.2	8.7	19.9	Not Applicable				120	AC	60	Single	3.5	375	D	PRINX14	
PRINX21	Desktop Laser Printer	Hewlett-Packard Business Sys.	LaserJet 4300n		O	O	Counter	16.4	16.9	14.4	46	Not Applicable				120	AC	60	Single		450 max.	D	PRINX21	
PRINX30	Color Inkjet Printer	Hewlett-Packard Business Sys.	DeskJet 5650	C6490E	O	O	Counter	17.7	14.6	5.7	11.7	Not Applicable				100	AC	60	Single		22	D	PRINX30	
PRINX31	Bubble Jet Printer	Canon USA Inc.	BJC-250		O	O	Counter	14.2	8.5	6.8	5.5	Not Applicable				120	AC	60	Single	0.5		V	PRINX31	
PRINX61	Network Laser Printer	Lexmark, An IBM Alliance Co.	T640dn	20G0130	O	O	Counter	16.6	25.1	15.6	49.1	Not Applicable			Y	120	AC	60	Single	8	675	D	PRINX61	
PRINX66	Graphic Laser Printer	Brother International Corp.	HL-5150D		O	O	Counter	15	15.8	13.9	37	Not Applicable				120	AC	60	Single		460	M	PRINX66	
PRINX71	Network Laser Printer	Hewlett-Packard Business Sys.	LaserJet 5200dtn	Q7546A	O	O	Counter	19.3	23.6	15.9	73	Not Applicable				110	AC	60	Single		600	D	PRINX71	
PRINX75	Desktop Printer	Hewlett-Packard Business Sys.	DeskJet 6122	C8954B	O	O	Counter	17.9	17.3	7.3	14.8	Not Applicable				120	AC	60	Single		35	D	PRINX75	
PRINX82	Laser Printer	Hewlett-Packard Business Sys.	LaserJet P3005	Q7812A	O	O	Counter	16.7	16.1	12.2	35.7	Not Applicable				120	AC	60	Single		600	D	PRINX82	
PRINX91	Laser Printer	Hewlett-Packard Business Sys.	LaserJet 4200tn	Q2427A	O	O	Counter	16.4	16.9	19.2	60	Not Applicable				120	AC	60	Single		580	D	PRINX91	
PROCT09	Tissue Processor, Benchtop	SAKURA Finetek U.S.A. Inc.	Tissue Tek VIP 5	5214	O	O	Counter	47.2	23.6	27.5	352	Not Applicable				115	AC	60	Single	11			PROCT09	
PROJV20	LCD Video Projector	NEC Technologies Inc.	NP1000		O	O	Counter	15.7	14.1	6.6	16.1	Not Applicable				120	AC	60	Single	4.6	365	M	PROJV20	
PROJV20A	Ceiling Mount for LCD Video Projector	Chief Manufacturing Inc.	RPA-1065		O	C	Ceiling	5.5	5.5	1.8		Not Applicable											PROJV20A	
PTICM03	Intermittent Compression Unit	Chattanooga Group Inc.	PresSsion Multi 3	4331	O	O	Counter	5.3	6.6	5.9	4.1	Not Applicable				110	AC	60	Single	.5	20		PTICM03	
PUMPI09	Intra-Aortic Balloon Pump	Datascope (now Maquet Getinge)	CS100	0998-11-3013-53	O	O	FloorStd	23.4	17.6	45.2	184.3	Not Applicable				115	AC	60	Single		400 VA	D	PUMPI09	
PUMPP03	Modular Perfusion Pump System (5 Pump)	Sarns/Terumo	Model 8000	16401 (5 Pump Base)	O	O	FloorStd	42.3	26.9	72	775					115	AC	60	Single	15		R	PUMPP03	
PUMPP03A	Arterial Monitor	Sarns/Terumo	Model 8000	16413	O	O	FloorStd															U	PUMPP03A	
PUMPP03B	Cardioplegia Monitor	Sarns/Terumo	Model 8000		O	O	FloorStd															U	PUMPP03B	
PUMPP03C	Pressure Transducer	Sarns/Terumo	Model 8000	16433301	O	O	FloorStd																PUMPP03C	
PUMPP03D	Pressure Monitoring Kit	Sarns/Terumo	Model 8000	16066100	O	O	FloorStd																PUMPP03D	
PUMPP03E	Pressure Transducer Holder	Sarns/Terumo	Model 8000	22300030	O	O	FloorStd																PUMPP03E	
PUMPP03F	Lamp	Sarns/Terumo	Model 8000	16420	O	O	FloorStd																PUMPP03F	
PUMPP03G	Battery Module	Sarns/Terumo	Model 8000	16422	O	O	FloorStd																PUMPP03G	
PUMPP14	Pharmacy (PN) Compounder- Control Unit	Baxter Healthcare-IV Sys. Div.	Automix 3+3		O	O	Accssry	18.5	6	7.5	7	Not Applicable				115	AC	60	Single		45	D	PUMPP14	
PUMPP14A	Pharmacy (PN) Compounder- Pump Unit	Baxter Healthcare-IV Sys. Div.	Automix 3+3		O	O	Accssry	20.5	12.5	21.5	31	Not Applicable										M	PUMPP14A	
PUMPR01	Repeater Pharmacy Pump	Baxa Corporation	095		O	O	Counter	7	10	10	30	Not Applicable				115	AC	60	Single		200		PUMPR01	
PUMPR03	Pharmacy Pump	Baxa Corporation	Repeater Pump 099	H938 099 3	O	O	Counter	8.3	12.8	9.8	24.2	Not Applicable				120	AC	60	Single		200 VA		PUMPR03	
PUNCH01	Electric 3-Hole Punch, Commercial	Acco Brands Inc	Swingline 74525	SWI74525	O	O	Counter	16.5	6	10	12	Not Applicable				120	AC	60	Single	1			PUNCH01	
RACKA18	Peg-Style Rack for 4 Aprons	AliMed Inc.	9-662		O	O	Wall-Mtd	19.5	5.3	3	3												RACKA18	
RACKA32	Peg-Style Rack for 7 Aprons	AliMed Inc.	9-630		O	O	Wall-Mtd	35.5	5.3	3	6												RACKA32	
RACKG12	Rack for 4 H/T Gas Cylinders	Anthony Welded Products Inc.	MCR-400		O	O	FloorStd	29	20	30	56	Not Applicable											RACKG12	
RACKL01	Allowance- Magazine Rack	(Manufacturer Unknown)		(Based on Peter Pepper 4034)	O	O	Wall-Mtd	16	3	51	18	Not Applicable											RACKL01	
RACKM04	Mop Rack / Closet Organizer, 34"w	Rubbermaid Products	1993 (Closet Org/Tool Holder)	(price per one; sold 4/pack)	O	C	Wall-Mtd	34	4.3	3.3	10.9	Not Applicable											RACKM04	
RACKM04A	Hook Set for Mop Rack	Rubbermaid Products	1994 (Value Kit)		O	C					0.7	Not Applicable											RACKM04A	
RADCA23	Digital Mobile Imaging C-Arm	GE/OEC Medical Systems Inc.	9800 ESP 15 F/PS		O	O	FloorStd	33	78	87	1000	Make Provision				115	AC	60	Single		15000	V	RADCA23	
RADCA23A	Dual Monitor Display Cart	GE/OEC Medical Systems Inc.	9800 ESP 15 F/PS		O	O	FloorStd	27	27	64												V	RADCA23A	
RDCAR15	Single-Plane Cardiac Imag. Sys	Philips Med Sys North America	Allura FD10 (Floor Version)	Poly Diagnost G	O	V	Maj Inst	104	138.7	87.6	1921					480	AC	60	Three	125		V	RDCAR15	
RDCAR15C	Patient Angiography Table	Philips Med Sys North America	Angio Diagnost 5		O	V	Maj Inst	115.4	24	40.9	787												RDCAR15C	
RDCAR15D	X-Ray Generator Cabinet	Philips Med Sys North America	Velara Generator 40E Cabinet		O	V	Maj Inst	21.7	27.8	77	510			Y								U	RDCAR15D	
RDCAR15F	Peripheral 40 E Cabinet	Philips Med Sys North America	Peripheral 40 E Cabinet		O	V	Maj Inst	21.7	26.5	77	510			Y								U	RDCAR15F	
RDCAR15J	Mains 40 E Cabinet	Philips Med Sys North America	Mains 40 E Cabinet		O	V	Maj Inst	21.7	26.5	77	710			Y								U	RDCAR15J	
RDCAR15K	System Power Distribution Unit	Philips Med Sys North America	PDU 4000/UPS		O	V	Maj Inst	21.6	20.5	57.7	860											U	RDCAR15K	
RDCAR15L	Ceiling Susp w/3 LCD Monitors	Philips Med Sys North America	Three LCD Monitor Suspension		O	V	Ceiling	153.5	138.2	64.1	585											V	RDCAR15L	
RDCAR15N	Ceiling Track with Rad. Shield	Philips Med Sys North America	Mavig Ceiling Track	with Rad Shield	O	V	Ceiling				167												RDCAR15N	
RDCAR15S	System Viewing/Control Console	Philips Med Sys North America	Viewing/Control Console		O	V	Maj Inst	72	36	30												V	RDCAR15S	
RDVAS22	Digital Single-Plane Angiography System	Philips Med Sys North America	Allura Xper FD20 Ceiling		O	V	Maj Inst				2557					480	AC	60	Three	125		V	RDVAS22	
RDVAS22A	Patient Angiography Table	Philips Med Sys North America	Angio Diagnost 5		O	V	Maj Inst	115.4	24	40.9	787						AC						RDVAS22A	
RDVAS22B	Generator Cabinet	Philips Med Sys North America	Velara Generator 40E		O	V	Maj Inst	21.7	27.8	77	510						AC					U	RDVAS22B	
RDVAS22C	Peripheral 40 E Cabinet	Philips Med Sys North America	Peripheral 40 E Cabinet		O	V	Maj Inst	21.7	26.5	77	510			Y			AC					U	RDVAS22C	
RDVAS22D	Mains 40 E Cabinet	Philips Med Sys North America	Mains 40 E Cabinet		O	V	Maj Inst	21.7	26.5	77	710			Y			AC					U	RDVAS22D	
RDVAS22E	System Power Distribution Unit	Philips Med Sys North America	PDU 4000/UPS		O	C	Maj Inst	21.6	20.5	57.7	860						AC					U	RDVAS22E	
RDVAS22F	System Viewing/Control Console	Philips Med Sys North America	Viewing/Control		O	V	Maj Inst	72	36	30	126						AC					V	RDVAS22F	
RDVAS22G	Documentation Box	Philips Med Sys North America	Documentation Box		O	V	Maj Inst	21.7	12.6	11.2	75											U	RDVAS22G	
RDVAS22H	Auxiliary Box	Philips Med Sys North America	Exam Room Auxiliary Box		O	V	Maj Inst	7.3	2.6	11.2	7						AC					U	RDVAS22H	
RDVAS22I	Three LCD Monitor Suspension	Philips Med Sys North America	Three LCD Monitor Suspension		O	V	Maj Inst				585						AC						RDVAS22I	
RDVAS22J	Ceiling Track with Rad. Shield	Philips Med Sys North America	Mavig Ceiling Trac w/ Rad Shld		O	V	Ceiling				167						AC						RDVAS22J	
READB02	Blood Bank Tube Viewer	Fisher Scientific	BD # 420630	22-252-490	O	O	Counter	5	8	12	7	Not Applicable				120	AC	60	Single	0.5			READB02	
RECBH07																								

ATTACHMENT A
HEALTHCARE EQUIPMENT SCHEDULE

Equip ID	Equipment Name	Manufacturer	Model	Model Part	Furnished By	Installed By	Position	Width (Inches)	Depth (Inches)	Height (Inches)	Weight (lbs.)	Approval	OPA #	HVAC Connection	Plumbing Connection	Volts	~	Hz	Phase	Amps	Watts	Data	Equip ID	
RECSH58	Sharps Container, 12 Gallon	Covidien (formerly Kendall)	8935		O	O	FloorStd	17.5	12.5	18.7													RECSH58	
REFBB17	One-Door Blood Bank Refrigerator	Helmer Labs, Inc.	IB125		O	O	FloorStd	29	36	79.8	559	Make Provision		Y		115	AC	60	Single	7.6		R	REFBB17	
REFBB17A	Anchor Bracket Kit	Helmer Labs, Inc.	400472-1		O	O	Accssry					Pending											REFBB17A	
REFBB18	Two-Door Blood Bank Refrigerator	Helmer Labs, Inc.	IB256	500907-1	O	O	FloorStd	59.3	38.5	79.8	890	Make Provision		Y		115	AC	60	Single	11.5		R	REFBB18	
REFBB18A	Anchor Bracket Kit	Helmer Labs, Inc.	400472-1		O	O	Accssry					Pending											REFBB18A	
REFBB30	Undercounter Blood Bank Refrigerator	Follett Corporation	REF5-BB		O	O	FloorStd	23.8	27.5	34	205	Not Applicable				115	AC	60	Single	8		D	REFBB30	
REFON39	1-Door Laboratory Refrigerator	Helmer Labs, Inc.	Horizon #HLR125		O	O	FloorStd	29	36	79.5	476	Make Provision				115	AC	60	Single	7.5		M	REFON39	
REFON39A	Anchor Bracket Kit	Helmer Labs, Inc.	400472-1		O	O	Accssry					Pending											REFON39A	
REFRP12	One Door Pharmacy Refrigerator	Helmer Labs, Inc.	Horizon HPR125		O	O	FloorStd	29	39.7	79.5	535	Make Provision		Y		115	AC	60	Single	7.5			REFRP12	
REFRP12A	Anchor Bracket Kit	Helmer Labs, Inc.	400472-1		O	O	Accssry					Pending											REFRP12A	
REFRZ09	Refrigerator/Freezer	Sears Contract & Indus. Sales	Kenmore 46-33721	(Replaced by 46-36642)	C	C	FloorStd	28	30.8	64.2	210	Make Provision				115	AC	60	Single	4.75	480		REFRZ09	
REFRZ45	17 cf Refrigerator/Freezer, w/o Icemaker	Sears Contract & Indus. Sales	Kenmore 46-61752	(old 46-60752, 46-31642)	O	O	FloorStd	28	31.4	65.1	190	Make Provision				115	AC	60	Single	4.5			REFRZ45	
REFTH08	Three-Door Lab Refrigerator	Kendro (formerly Revco)	REL-7504A		O	O	FloorStd	85	33.5	77.5	805	Make Provision		Y		115	AC	60	Single	16			REFTH08	
REFTH11	Three-Door Pass-Through Refrigerator	Gem Scientific	Model 65 Pass-Thru	(with sliding doors)	O	O	FloorStd	78	31.5	71	1100	Make Provision				120	AC	60	Single	11			REFTH11	
REFTW24	2-Door Laboratory Refrigerator	Helmer Labs, Inc.	HLR256		O	O	FloorStd	59	36	78.5	793	Make Provision		Y		115	AC	60	Single	11.5		D	REFTW24	
REFTW24A	Anchor Bracket Kit	Helmer Labs, Inc.	400472-1		O	O	Accssry					Pending											REFTW24A	
REFTW29	Two-Door Lab Refrigerator with Monitor	Helmer Labs, Inc.	HLR256		O	O	FloorStd	59	36	78.5	793	Make Provision		Y		115	AC	60	Single	11.5		D	REFTW29	
REFTW29A	Anchor Bracket Kit	Helmer Labs, Inc.	400472-1		O	O	Accssry					Pending											REFTW29A	
REFTW31	Two-Door Pass-Through Refrigerator	Gem Scientific	2DR Pass-Thru	Swinging Doors	O	O	FloorStd	62.1	35.8	82	800	Make Provision				120	AC	60	Single	11			REFTW31	
REFTW40	Two-Door Pharmacy Refrigerator	Gem Scientific	45 Pass-Thru		O	O	FloorStd	54	31.5	71	840	Make Provision				120	AC	60	Single	11			REFTW40	
REFUN10	Undercounter Refrigerator/Freezer	Marvel Scientific	6CRF		O	O	FloorStd	23.9	24	34.5	90	Not Applicable				120	AC	60	Single	2.5			REFUN10	
REFUN51	Med Grade Underctr. Refrig- ADA Height	Follett Corporation	REF4-ADA (31.3"h for ADA ctop)		O	O	FloorStd	24	25.5	31.3	175	Not Applicable				115	AC	60	Single	8.0		U	REFUN51	
REFUN69	Lab/Pharmacy Undercounter Refrigerator	Helmer Labs, Inc.	HLR105		O	O	FloorStd	24	29	33.5	188	Not Applicable				115	AC	60	Single	5.0 FLA		D	REFUN69	
REFUN69A	Anchor Bracket Kit	Helmer Labs, Inc.	400472-2		O	O	Accssry					Pending											REFUN69A	
REGIS11	ADL Cash Register	Sharp Electronics Corporation	ER-A330		O	O	Counter	17	17	14	37	Not Applicable				120	AC	60	Single	0.3	38		REGIS11	
REGVC13	Continuous Vacuum Regulator	Allied Healthcare Products	Chemetron Vacutron	22-12-1108 (old22-12-0100)	O	O		2.7	4.1	6.8	1.3	Not Applicable											REGVC13	
REGV14	Intermittent/Continuous Vacuum Regulator	Boehringer Laboratories Inc.	Silver Series	7804	O	O	Portable		3.8	5.8	1.8	Not Applicable											REGV14	
RESUS01	Adult Manual Resuscitator	Nellcor (div. Tyco Healthcare)	PMR 2	6-153011-00/4-231142-00	O	O	Portable	22.8			2	Not Applicable											RESUS01	
ROBOS01	Robotic Surgeon Console	Intuitive Surgical Inc.	daVinci Surgical System	Surgeon Console	O	V	FloorStd	36	62	66	500	No		Y		115	AC	60	Single	12	1400 VA max	D	ROBOS01	
ROBOS01A	Robotic Surgery Cart	Intuitive Surgical Inc.	daVinci Surgical System	Surgical Cart	O	V	FloorStd	37	38	79	1200	No				115	AC	60	Single			D	ROBOS01A	
ROBOS01B	Robotic Vision Cart	Intuitive Surgical Inc.	daVinci Surgical System	Vision Cart	O	V	FloorStd	22	27	60	175	No		Y		115	AC	60	Single	10	1100 VA max	D	ROBOS01B	
ROBOS01C	Fourth Arm Option on Da Vinci	Intuitive Surgical Inc.	daVinci Surgical System		O	V						Not Applicable										D	ROBOS01C	
ROBOS01D	Initial Instruments/Accessories	Intuitive Surgical Inc.	daVinci Surgical System		O	V	Accssry					Not Applicable											ROBOS01D	
ROLLE11	Bariatric Patient Transfer System	HoverTech International	HoverMatt H50HS (mattress)	Air 400G (air supply)	O	O	Portable	78	50							110	AC	60	Single	9.0			ROLLE11	
ROTAT13	Rotator	Fisher Scientific	Clinical Rotator 341	14-252Q	O	O	Counter	8	10.5	4.5	7	Not Applicable				115	AC	60	Single	0.026			ROTAT13	
ROTAT21	Lab Rotators	Barnstead International	2314Q		O	O	Counter	13.6	12.5	4.4	17	Not Applicable				120	AC	60	Single	.4	50		ROTAT21	
SAFEX03	Security Safe	Gardall Safe Corporation	RC1228C Depository Safe		O	O	FloorStd	14.5	13	25	160	Not Applicable											SAFEX03	
SCALE16	Patient Scale	Detecto div Cardinal Scale Mfg	439		O	O	FloorStd	16.3	21	59	38	Not Applicable											SCALE16	
SCAND12	Document Scanner	Hewlett-Packard Business Sys.	ScanJet 5300Cxi	7693A	O	O	Counter	12	20	4	8.1	Not Applicable				115	AC	60	Single		19 max.	D	SCAND12	
SCAND35	Document Scanner	Fujitsu	fi-5120C		O	V	Counter	11.9	6.6	6.2	8.4	Not Applicable				100	AC	60	Single		34	D	SCAND35	
SCANU91	Ultrasound Scanner for Vascular Access	Bard Access Systems Inc.	Site-Rite V - CVC Access	9760029	O	O	Cart-Mtd	12	5	13	10					120	AC	60	Single	2	84 (max)	V	SCANU91	
SCANU91A	Rolling Stand for SiteRite Ultrasound	Bard Access Systems Inc.	Site-Rite V Standard Roll Stan	9760031	O	O	FloorStd	24	24	54	50					120	AC	60	Single	1.7			SCANU91A	
SCOPE39	Clinical Lab Microscope	Leica Inc.	DM LS (LSR B CL HP)	501095/501055/501062/506094	O	O	Counter	11.5	15.6	17	19.8	Not Applicable				115	AC	60	Single		30		SCOPE39	
SCOPE40	Phase Polarizing Microscope	Olympus America Inc.	BX40		O	O	Counter	11.1	17.4	15.7	25.3					120	AC	60	Single		80 VA		SCOPE40	
SCOPE41	Clinical Microscope, Dual Side-by-Side	Olympus America Inc.	BX40	Dual-Viewing Microscope	O	O	Counter	11.1	17.4	15.7	25.3					120	AC	60	Single		80 VA		SCOPE41	
SCOPE46	Microscope	Olympus America Inc.	BH2		O	O	Counter	10	15	18						115	AC	60	Single		20		SCOPE46	
SCOPE49	Clinical Microscope, Dual Face-to-Face	Olympus America Inc.	BX41 w/ Dual-View Attachment		O	O	Counter	11.2	24.4	17						120	AC	60	Single		30		SCOPE49	
SCOPE67	Ergonomic Microscope	Olympus America Inc.	BX45		O	O	Counter	11.1	18	21.3	25.3					120	AC	60	Single		80 VA		SCOPE67	
SCOPE69	Clinical Microscope	Nikon Inc., Instrument Group	Eclipse 50i	MBA85020	O	O	Counter	7.2	15.1	14.1	9	Not Applicable				120	AC	60	Single	0.9			SCOPE69	
SCOPE73	Stereomicroscope	American Optical	1810		O	O	Counter	7	10.5	23		Not Applicable				120	AC	60	Single		29		SCOPE73	
SCOPZ04	Microscope Camera	Nikon Inc., Instrument Group	FX-3SWA		O	O	Accssry					Not Applicable										U	SCOPZ04	
SCREN01	Folding Privacy Screen	Winco Incorporated	3130	(Old 313)	O	O	FloorStd	82		69	25	Not Applicable											SCREN01	
SCREP04	Ceiling-Mtd Electric Projection Screen	Da-Lite Screen Company	Senior Electrol 70 X 70	40584	O	C	Ceiling	93	9.5	11.3	133	Make Provision				120	AC	60	Single	2.5			SCREP04	
SEALH06	Impulse Heat Sealer	Uline Shipping Supply	H-963		O	O	Counter	3	20	8	12.7	Not Applicable				115	AC	60	Single		310		SEALH06	
SHELF01	Mobile Wire Shelving, 4 Tiers	InterMetro Industries Corp.	Mobile 3 Wire Tiers & 1 Solid		O	O	FloorStd	60	24	69	112	Make Provision											SHELF01	
SHELF02	Mobile Wire Shelving, 60" w x 18" d	InterMetro Industries Corp.	5 Tiers: 4 Wire, Bottom Solid		O	O	FloorStd	60	18	68	108	Make Provision											SHELF02	
SHELF04	Mobile Chrome Wire Shelving, 4 Tiers	InterMetro Industries Corp.	N356BC		O	O	FloorStd	48	18	69	72	Make Provision											SHELF04	
SHELF10	Mobile Wire Shelving, 4 Tiers	InterMetro Industries Corp.	#74UP(4), #5MP(4), #A2448NC(4)		O	O	FloorStd	48	24	80	90	Make Provision											SHELF10	
SHELF20	Mobile Wire Shelving Unit	InterMetro Industries Corp.	ECM56XA Linen Exchange Cart		O	O	FloorStd	60	24	69		Make Provision											SHELF20	
SHELF20A	Zippered Nylon Cover for Shelf	InterMetro Industries Corp.	24X60X62UC (White) or	24X60X62UCMB (Mariner Blue)	O	O	Accssry	60	24	62		Not Applicable											SHELF20A	
SHELF46	Six-Tier Filing Unit with Flipper Doors	Holga Inc. (see HONCO)			O	O	FloorStd	36	13.5	78		Make Provision											SHELF46	
SHELF64	S/S Mobile Shelving Unit	InterMetro Industries Corp.		SEE ACCESSORIES	O	O	FloorStd					Make Provision											SHELF64	
SHELF64A	Solid Stainless Shelf	InterMetro Industries Corp.	2460FS		O	O	FloorStd	60	24		31	Not Applicable											SHELF64A	
SHELF64B	Stainless Steel Post	InterMetro Industries Corp.	63UPS		O	O	FloorStd			62	3.5	Not Applicable											SHELF64B	
SHELF64C	Polymer Swivel Stem Caster	InterMetro Industries Corp.	5PC		O	O	FloorStd	1.3	5	5	2	Not Applicable											SHELF64C	
SHELF64D	Polymer Brake Stem Caster	InterMetro Industries Corp.	5PCB		O	O	FloorStd	1.3	5	5	2	Not Applicable											SHELF64D	
SHELF64E	Installation	InterMetro Industries Corp.	FOR ITEM #4 ON QUOTE		O	O	FloorStd					Not Applicable											SHELF64E	
SHELP06	Pharmacy Shelving Unit Allow.	Herman Miller Inc. (Furniture)			O	O	FloorStd	48	15.5	79		Not Applicable											SHELP06	
SHELP12	Pharmacy Shallow-Depth Shelving Unit	(Manufacturer Unknown)			O	O	FloorStd	30	7	84		Make Provision											SHELP12	
SHELV40	Chrome Wire Shelving, 36" w x 18" d	InterMetro Industries Corp.		1836NC (x5); 74P (x4)	O	O	FloorStd	36	18	74.6	63.5	Pre-Approved	OPA-0556										SHELV40	
SHELV61	Chrome Wire Shelving, 60" w x 24" d	InterMetro Industries Corp.		2460NC (X5); 86P (X4)	O	O	FloorStd	60	24	86.6	125	Pre-Approved	OPA-0556										SHELV61	
SHELV61A	Seismic Floor Plates	InterMetro Industries Corp.	SASES25BP-1		O	O	FloorStd	7	2.9	4.2		Pre-Approved	OPA-0556										SHELV61A	
SHELV69	Chrome Wire Shelving, 60" w x 18" d	InterMetro Industries Corp.		1860NC (x5); 74P (x4)	O	O	FloorStd	60	18	74.6	101	Pre-Approved	OPA-0556										SHELV69	
SHELV69A	Seismic Floor Plates																							

ATTACHMENT A
HEALTHCARE EQUIPMENT SCHEDULE

Equip ID	Equipment Name	Manufacturer	Model	Model Part	Furnished By	Installed By	Position	Width (Inches)	Depth (Inches)	Height (Inches)	Weight (lbs.)	Approval	OPA #	HVAC Connection	Plumbing Connection	Volts	~	Hz	Phase	Amps	Watts	Data	Equip ID	
STAIN22	Automatic Slide Stainer	Leica Inc.	Autostainer XL	ST 5010	O	O	Counter	42.9	26.4	20.1	143.4	Not Applicable			Y	110	AC	60	Single	4			STAIN22	
STAIN30	Automatic Staining Module	Ventana Medical Systems, Inc.	NexES Special Stains	N750-NXSS-M (SM 850-000)	O	O	Counter	16	20	13.5	40	Not Applicable				120	AC	60	Single	8		D	STAIN30	
STAIN30A	Bulk Fluid Module for Staining System	Ventana Medical Systems, Inc.	NexES Special Stains	N750-NXSS (BFM 850-001)	O	O	Counter	13.5	14.5	13.5	30	Not Applicable										U	STAIN30A	
STAIN52	Automatic Linear Stainer	SAKURA Finetek U.S.A. Inc.	Tissue-Tek Prisma	Automated Slide Stainer	O	O	Counter	62	28	24.7	330					120	AC	60	Single	9			STAIN52	
STAIV06	Four-Hook IV Stand with Five-Prong Base	The Brewer Company	Entree 11360		O	O	FloorStd	18	18	64	14	Make Provision											STAIV06	
STAMA03	Mayo Stand with 16" x 21" Tray	Pedigo	P-1066-SS		O	O	FloorStd	21.3	16.3	39	33	Not Applicable											STAMA03	
STAMA15	Mayo Stand with 20" x 25" Tray	Pedigo	P-1065-SS		O	O	FloorStd	21	27	39	44	Not Applicable											STAMA15	
STAPR10	Allowance- C'top Printer Stand	(Manufacturer Unknown)	(based on Global Mini-Stand)	(typical of ZFC9821)	O	O	Counter	14	13	4	1	Not Applicable											STAPR10	
STEPS01	Rolling Step Stool	Cramer Inc.	The Original Kik-Step	1001	O	O	FloorStd	16	16	14	8.3	Not Applicable											STEPS01	
STEPS02	Stacking Step Stool for OR's	Phelan Manufacturing Corp.	5058-1 Add-A-Unit Step Stand	PMC#5058-1	O	O	FloorStd	17.5	13	4.6	8	Not Applicable											STEPS02	
STEPS02A	Cart for Stacking Step Stools	Phelan Manufacturing Corp.	Add-A-Unit Step Stand Cart	PMC#5058-77	O	O	FloorStd	16	19.5	36	22	Not Applicable											STEPS02A	
STEPS25	Step Stool with Handrail	Pedigo	P-10-A		O	O	FloorStd	16	12	38.5	20	Not Applicable											STEPS25	
STERI60	Vacuum Steam Sterilizer	Steris Corporation	Eagle Century V116	FS12-110-01	O	C	Maj Inst	26	35.8	74.5	750	Pre-Approved	OPA-0531		Y	120	AC	60	Single	2		R	STERI60	
STIMN13	Nerve Stimulator/Locator	Tri-Anim Health Services Inc.	EZStim II	488-ES400	O	O	FloorStd	3.3	6	2.3	1	Not Applicable										M	STIMN13	
STIRH05	Hot Plate	(Manufacturer Unknown)	American Dade Tek-Plate 20	H2140-1	O	O	Counter	4.5	4.5	5	5					120	AC	60	Single		3.3		STIRH05	
STOOL03	Utility Stool without Back	Pedigo	P-35		O	O	FloorStd	14	14	27	20	Not Applicable											STOOL03	
STOSU03	Hydraulic Surgical Stool with Round Seat	Stryker Medical	830-1 Surgistool II		O	O	FloorStd					Not Applicable											STOSU03	
STRTP10	Procedure/Recovery Stretcher	Stryker Medical	1550 Synergy Series	Extended Stay Stretcher	O	O	FloorStd	84	34	22	325	Not Applicable				120	AC	60	Single	7.0			STRTP10	
STRTR04	PACU/Recovery Stretcher	Stryker Medical	1500 Consta-Care I		O	O	FloorStd	33	84		290	Not Applicable											STRTR04	
STRTR35	PACU/Emergency 26" Stretcher, 5th Wheel	Stryker Medical	M Series SM104, 26" w/options	1007-000-000	O	O	FloorStd	33.5	84	34	304												STRTR35	
STRTR35A	Allowance for Stretcher Accessories	Stryker Medical	M Series	(to be selected)	O	O	Accssry																STRTR35A	
STRTR37	PACU/Emergency Stretcher with Big Wheel	Stryker Medical	M Series SM204 w/ Big Wheel	(26"w litter) 1015-000-000	O	O	FloorStd	33.5	84	34	304	Not Applicable											STRTR37	
STRTR37A	Accessory Allowance for Stretcher	Stryker Medical			O	O	Accssry					Not Applicable											STRTR37A	
TABLCO4	Allowance- Conference Table	(Manufacturer Unknown)			O	O	FloorStd	132	48	30		Not Applicable											TABLCO4	
TABLE01	Allowance- End Table	(Manufacturer Unknown)			O	O	FloorStd	23	23	22	30	Not Applicable											TABLE01	
TABLE07	Allowance- Table for Four, 42" Diameter	(Manufacturer Unknown)			O	O	FloorStd	42	42	28.5	81	Not Applicable											TABLE07	
TABLE58	Allowance- 48" Square Table	(Manufacturer Unknown)			O	O	FloorStd	48	48	27		Not Applicable											TABLE58	
TABLE63	Six-Person Round Table	The FurnitureLab	COM Laminate/Standard Option		O	O	FloorStd	60	60	28.5		Not Applicable											TABLE63	
TABLFO2	Folding Conference Table, 84"w x 18"d	Berco Tableworks Ltd	Proteus Plus PF-1884		O	O	FloorStd	84	18	30		Not Applicable											TABLFO2	
TABLO01	Over-operating (Straddle) Table	Pedigo	P-5182-SS		O	O	FloorStd	32	42	54.3	105	Not Applicable											TABLO01	
TABLS24	C-Arm Surgical Table	Steris Corporation	Amsco 3085 SP	BL54-730-432; ST010102	O	O	FloorStd	86		44	730	Make Provision				120	AC	60	Single	4.5			TABLS24	
TABLS24B	Accessory Package for Surgical Table	Steris Corporation			O	O						Not Applicable										M	TABLS24B	
TABLS24G	Siderail Supports for Surgical Table	Steris Corp. (formerly AMSCO)	BF13-300		O	O						Not Applicable										M	TABLS24G	
TABLS24H	Multiple Accessory Clamp Set for Surg Tb	Steris Corp. (formerly AMSCO)	BF43-000		O	O						Not Applicable											TABLS24H	
TABLU01	Utility Table with Two Drawers	Blickman Health Industries	George 7754SS	0227754000	O	O	FloorStd	20	16	34	65	Not Applicable											TABLU01	
TABOV03	Overbed Table	Stryker Medical	Companion I Single Top		O	O	FloorStd	23.5	33.5	43.5	62	Not Applicable											TABOV03	
TEGX002	Thrombelastograph (TEG) Coag Analyzer	Haemoscope Corporation	TEG 5000 Thrombelastograph		O	O	Counter	9.8	10.2	11.4	13.2	Not Applicable				120	AC	60	Single	0.42	46	V	TEGX002	
TELEF14	52" Widescreen LCD HDTV	Sharp Electronics Corporation	Aquos	LC-52D64U	O	O		45.7	12.8	32.9	74.9	Not Applicable				120	AC	60	Single		290	M	TELEF14	
TELEV94	20" Flatscreen Hosp Television	Zenith Electronics Corporation	L20V26		O	C	Counter	22.7	8.1	18.7	25.4	Not Applicable				120	AC	60	Single		70	D	TELEV94	
TELEV94A	Tilting Wall Mount for Television	Peerless Industries Inc.	ST630	Flat/Tilting Wall LCD Mount	O	C	Wall-Mtd	2.9	2			No											TELEV94A	
TELEV97	42" Plasma Television	Philips Electronics	HD Series 42" Plasma	42PF9936D/37	O	O	Counter	47.9	3.6	26	95	Not Applicable				120	AC	60	Single		450	D	TELEV97	
TELEZ11	Wall Mt for Flat Screen 32" to 56" TV	Peerless Industries Inc.	SmartMount ST650		O	C	Wall-Mtd	30.9	2.6	18.5	7.9	Pre-Approved	OPA-1546										TELEZ11	
TELEZ12	Wall Mount for Flat Screen- 37" to 60"	Peerless Industries Inc.	SmartMount ST660		O	C	Wall-Mtd	34.1	2.6	18.5	8.2	Pre-Approved	OPA-1546										TELEZ12	
TERMC01	Computer CPU	(Manufacturer Unknown)	(Info Sys Dept to Specify)		O	O	Counter	7.1	15	14.2	24.2	Not Applicable				120	AC	60	Single	3 typical	300	D	TERMC01	
TERMF15	15" Flat Panel Monitor	(Manufacturer Unknown)	(Info Sys Dept to Specify)		O	O	Counter	14.4	8	14	9	Not Applicable				115	AC	60	Single		25		TERMF15	
TERMF17	17" Flat Panel Monitor	(Manufacturer Unknown)	(Info Sys Dept to Specify)		O	O	Counter	14.8	7.6	15.6	11	Not Applicable				120	AC	60	Single		70		TERMF17	
TERMF19	19" Flat Panel Monitor	(Manufacturer Unknown)	(Info Sys Dept to Specify)		O	O	Counter	16.3	8.5	16.5	19.5	Not Applicable				115	AC	60	Single		55		TERMF19	
TERMF20	20" Flat Panel Monitor	(Manufacturer Not Identified)	(Info Sys Dept to Specify)		O	O	Counter	17.6	9.7	25	18.7	Not Applicable				120	AC	60	Single		55	V	TERMF20	
TERMF21	21" Flat Panel Monitor	(Manufacturer Unknown)	(Info Sys Dept to Specify)		O	O	Wall-Mtd	18.4	10.2	18.6	20.9	Not Applicable				115	AC	60	Single		65		TERMF21	
TERMF24	24" Flat Panel Monitor w/ Stand	(Manufacturer Unknown)	(Info Sys Dept to Specify)	(typical of Dell)	O	O	Counter	22.1	8.5	19.6	21.8	Not Applicable				120	AC	60	Single	2 max		V	TERMF24	
TERMP08	Pocket PC	Symbol Technologies, Inc.	SPT 1800 Series	TRG80400	O	O	Counter	3.6	7	1	10.6	Not Applicable										W	TERMP08	
TERMW01	Wall Mount for CPU, Monitor, & Keyboard	Ergotron Inc.	LX Wall Mount, 45-238-194	(Replaces LX 28-518-194)	O	C	Wall-Mtd				49	Pre-Approved	OPA-2338-07										TERMW01	
TERMW01A	Wall Mount LCD Arm	Ergotron Inc.	45-180-194		O	C	Wall-Mtd		24		11	Not Applicable											TERMW01A	
TERMW01B	Track Mount Bracket Kit	Ergotron Inc.	97-091		O	C	Wall-Mtd				1	Not Applicable											TERMW01B	
TERMW05	Wall Mount for CPU, Monitor, & Keyboard	GCX Corporation	VHC Variable Height Channel	FWM-0001-13	O	C	Wall-Mtd	6.5	1.2	49	12	Pre-Approved	OPA-1665-07										TERMW05	
TERMW05A	Articulating Arm for Flat Panel Displays	GCX Corporation	M-Series 8"x8" Articulating Ar	FLP-0009-05	O	C	Wall-Mtd		16.5		5.5												TERMW05A	
TERMW05B	Articulating Arm w/ Swivel Only Head	GCX Corporation	M-Series 8"x8" Articulating Ar	WMM-0005-05	O	C	Wall-Mtd				4.5												TERMW05B	
TERMW05C	Keyboard Tray for Mounting System	GCX Corporation	Keyboard Tray 25.75"	WM-0023-32	O	C	Wall-Mtd	25.8	8.5		7												TERMW05C	
TERMW05D	Fold up Keyboard Bracket	GCX Corporation	Fold up Keyboard Bracket	WM-0010-65	O	C	Wall-Mtd				2												TERMW05D	
TERMW05E	CPU Holder with Wall Channel	GCX Corporation	CPU Mount with Wall Channel	WM-0007-41/WC-0002-01	O	C	Wall-Mtd	14	4.5	14	25												TERMW05E	
THERM14	Electronic Patient Thermometer	Welch Allyn Inc.	SureTemp Plus 692	01692-200	O	O	Wall-Mtd	3	2.3	7	0.7	Not Applicable											THERM14	
THERM14A	Wall Mount for Patient Thermometer	Welch Allyn Inc.	(included with 01692-200)		O	O	Wall-Mtd	6	3	5.5		Not Applicable											THERM14A	
TIMEC10	Coagulation Timer	International Technidyne Corp.	Hemochron Response	HRS ____ (specify voltage)	O	O	Counter	10.6	7.5	8.7	6.4	Not Applicable				120	AC	60	Single	3 max.	36 max.		TIMEC10	
TIMER05	Lab Multiple Test Timer	Baxter Scientic Products Div.	(vendor # C6541)		O	O	Counter	11	7.5	6	3	Not Applicable				115	AC	60	Single	.2			TIMER05	
TIMER08	Programmable Multi-Timer	Fisher Scientific	Model 151	Catalog No. 06-657-50	O	O	Counter	8.3	11	4.5	3.8	Not Applicable				120	AC	60	Single	.08			TIMER08	
TIMER11	Time Recorder	Amano Electronics of America	Typical of NS-5100		O	O	Wall-Mtd	7	5	7.8	5.1	Not Applicable				120	AC	60	Single		30 max		TIMER11	
TRACC01	Ceiling Track for Curtain	Automated IV Systems Inc.	7989 Cubey Kit		O	C	Ceiling					Not Applicable											TRACC01	
TRACIO2	"U"-Shaped IV Track	A.R. Nelson Company Inc.	#1100 Track		C	C	Ceiling																TRACIO2	
TRACIO2A	IV Bottle Holder for IV Track	A.R. Nelson Company Inc.	Model 4000		C	C	Ceiling																TRACIO2A	
TRACIO2B	Bottle Carrier for IV Track	A.R. Nelson Company Inc.	NC 100		C	C	Ceiling																TRACIO2B	
TRACIO3	Ceiling-Mtd Straight IV Track- 48" long	A.R. Nelson Company Inc.	1100IV		C	C	Ceiling																TRACIO3	
TRACIO3A	Carrier for Ceiling-Mtd IV Track	A.R. Nelson Company Inc.	NC-100		C	C	Ceiling																TRACIO3A	
TRACIO3B	Bottle Holder for Ceiling-Mtd IV Track	A.R. Nelson Company Inc.	#4000		C	C	Ceiling																TRACIO3B	
TRANS04	Autologous Transfusion System	Haemonetics	Cell Saver 5	2005-110-E	O	O	FloorStd	19	23	88.5	106	Make Provision				110	AC	60	Single	4		R	TRANS04	
TURBIO1	Turbidity Meter	VWR Scientific	VWR # 66120-200	Model 800 Turbidity Meter	O	O	Counter																	

ATTACHMENT A HEALTHCARE EQUIPMENT SCHEDULE																								
Equip ID	Equipment Name	Manufacturer	Model	Model Part	Furnished By	Installed By	Position	Width (inches)	Depth (inches)	Height (inches)	Weight (lbs.)	Approval	OPA #	HVAC Connection	Plumbing Connection	Volts	~	Hz	Phase	Amps	Watts	Data	Equip ID	
WARMB32	Full-Height Two-Chamber Warming Cabinet	Steris Corporation	Amsco 24"d Double-Compartment	DJ06-012-133 Glass Doors	O	C	FloorStd	30	26.5	74.8	210	Pre-Approved	OPA-0515			120	AC	60	Single	13.7	1600		WARMB32	
WARMC03	Contrast Media Warmer	Merry X-Ray	Mallinckrodt 1550-CW	406387	O	O	Counter	20	17	15.3	25.5	Not Applicable				120	AC	60	Single	3	250		WARMC03	
WARMF01	Blood and IV Fluid Warmer	SIMS Level 1 Inc.(Smith Med)	Hotline HL-90		O	O	Portable	8.3	7	9.5	7.6	Not Applicable				120	AC	60	Single	3			WARMF01	
WARMS02	Slide Warming Table	Lab-Line-Barnstead/Thermolyne	26005 Slide Warmer		O	O	Counter	14	14	3.5		Not Applicable				120	AC	60	Single	1.3	160		WARMS02	
WASBH21	Biohazardous Waste Receptacle, 44 Gallon	Rubbermaid Products	2643 Brute (44 Gallon)	(priced per 1; sold per 4)	O	O	FloorStd	24	24	31.5	14	Not Applicable											WASBH21	
WASHC01	Cell Washer, Blood Bank	Kendro Laboratory Products	CW2	04500	O	O	Counter	12.5	14	22.5	36	Not Applicable				115	AC	60	Single	2	200		WASHC01	
WASTE01	Fire-Resistant Waste Receptacle, 28 Qt	Rubbermaid Products	2543 (priced per 1; sold per 6	Grainger # 5M74x	O	O	FloorStd	14.5	10.5	15.3	4	Not Applicable											WASTE01	
WASTE02	Allowance- Designer Waste Receptacle	(Manufacturer Unknown)		(Based on McDonald 1443-XX)	O	O	FloorStd	11	11	30	22	Not Applicable											WASTE02	
WASTE03	Waste Receptacle, 23 Gallon	Rubbermaid Products	3540 Slim Jim		O	O	FloorStd	20.4	11.4	30	8	Not Applicable											WASTE03	
WASTE03B	Swing Top Lid for Waste Receptacle	Rubbermaid Products	Slim Jim Swing Lid	2673-60	O	O	Accssry	20.5	11.6	5	3.1												WASTE03B	
WASTE04	Waste Receptacle, 44 Gallon	Rubbermaid Products	2643 Brute		O	O	FloorStd	27	27	38.1	14	Not Applicable											WASTE04	
WASTE04A	Dolly for Waste Receptacle	Rubbermaid Products	2640 Brute Dolly		O	O	Accssry	18.5	18.5	6.6	13.1	Not Applicable											WASTE04A	
WASTE04B	Cover for Waste Receptacle	Rubbermaid Products	2645-60 Brute Lid		O	O	Accssry	26.8	26.8	1.5	4	Not Applicable											WASTE04B	
WASTE40	Recycling Container for Paper, 23-Gallon	Rubbermaid Products	Slim Jim 3540-75		O	O	FloorStd	20	11	30		Not Applicable											WASTE40	
WASTE44	Waste Receptacle, Bullet Shape	Rubbermaid Products	8160-88 Marshal		O	O	FloorStd			36.5		Not Applicable											WASTE44	
WASTE53	Recycling Container, 23 Gallon	Rubbermaid Products	3569-07 (old 3569-06)	(priced per 1; sold per 4)	O	O	FloorStd	14.5	14.5	28	7	Not Applicable											WASTE53	
WASTE58	Recycling Container, 28 Quart	Rubbermaid Products	2956-06 (Green) or	2956-73 (Blue)	O	O	FloorStd	14.4	10.3	15	1.8	Not Applicable											WASTE58	
WASTF02	95-Gallon Waste Container	Rubbermaid Products	9W22		O	O	Portable	27.3	36	45.5	36	Not Applicable											WASTF02	
WINDO01	Allowance- Window Treatment	(Manufacturer Unknown)			O	O	Wall-Mtd					Not Applicable											WINDO01	
WORKC13	Mobile Computer Workstation w/Keybd Tray	Anthro Technology Furniture	GT03-____ (last 2 letters color)	615PG &	O	O	FloorStd	25.5	30	28	56	Not Applicable											WORKC13	
WORKC15	Mobile Computer Cart	Ergotron Inc.			O	O		27	27	55	72	Not Applicable											WORKC15	
WORKC15A	LCD Arm	Ergotron Inc.	45-007-099		O	O		22.9			13	Not Applicable											WORKC15A	
WORKC15B	Keyboard Arm	Ergotron Inc.	45-006-099		O	O					12	Not Applicable											WORKC15B	
WORKC15C	Keyboard Tray	Ergotron Inc.	77-050-180		O	O					7	Not Applicable											WORKC15C	
WORKC48	Variable Height Wall Mounted CPU Wrkstn	GCX Corporation			O	O	Wall-Mtd	37	37.7	37	35.4	Pre-Approved	OPA-0079-07										WORKC48	
ZPAPR13	Paper Towel Roll Dispenser	Kimberly Clark Corp.	"In-Sight" Series	09114-00 or 09746	O	O	Wall-Mtd	10.5	10	10	9	Not Applicable											ZPAPR13	
ZPAPR19	Paper Towel Dispenser	Bobrick Washroom Equipment Inc	B-262 C-Fold		O	C	Wall-Mtd	10.8	4	14	4.8	Not Applicable											ZPAPR19	
ZSKIN02	Dispenser for 1000 ml Hand Sanitizer	W.W. Grainger Inc.	Purell 2120	SVN15	O	C	Wall-Mtd	5	3.8	10	0.8	Not Applicable											ZSKIN02	
ZSKIN05	Dispenser for 2000 ml Hand Sanitizer	GOJO Industries	2220-08 Purell® Nxt®	Maximum Capacity Dispenser	O	C	Wall-Mtd	6.6	4.8	10.6	1.5	Not Applicable											ZSKIN05	
ZSOAP03	Foot-Operated Surgical Soap Dispenser	(Manufacturer Unknown)	(typical of Bradley # 6843)		O	C	Wall-Mtd	4.5	9	9.5		Not Applicable											ZSOAP03	
ZSOAP09	Soap Dispenser	Steris Corporation	Calgon Vestal EZ Touch	1173Q2 (White)	O	C	Wall-Mtd	5.7	5	10.5		Not Applicable											ZSOAP09	
ZSRES01	Liquid Dispenser Residue Catch	Northern Acrylics Inc.	Dispenser Guard		O	C	Wall-Mtd	7	4.2	14		Not Applicable											ZSRES01	
GENERAL NOTES:																								
A.	FOR WALL MOUNTED EQUIPMENT OVER 20 POUNDS, PROVIDE BACKING PLATES AS SHOWN ON A10.06																							
B.	SEE MECHANICAL, PLUMBING AND ELECTRICAL DRAWINGS FOR MORE INFORMATION.																							
C.	REFER TO EQUIPMENT CUT SHEETS FOR ADDITIONAL INFORMATION.																							
D.	REFERE TO A3 SERIES PLANS FOR EQUIPMENT LOCATIONS AND QUANTITIES.																							
E.	REFERE TO A9 SERIES INTERIOR ELEVATIONS FOR ADDITIONAL INFORMATION AND MOUNTING HEIGHTS.																							
LEGEND																								
C	CONTRACTOR																							
O	OWNER																							
V	VENDOR																							
Y	YES																							
DATA COLUMN																								
D	NETWORK CONNECTION (DATA)	I	POSSIBLE INTERFERENCE WITH WIRELESS																					
N	NO	P	PHONE																					
R	RS232 PORT	M	NETWORK CONNECTION																					
U	UNDETERMINED																							
V	NETWORK CONNECTION (VIDEO AND DATA)																							
W	WIRELESS																							

SECTION 14 11 00

DUMBWAITER

PART 1 – GENERAL

1.01 DESCRIPTION

- A. Work Included in This Section: Provide electric dumbwaiters complete as shown and specified.
- B. Related Work Not Included in This Section:
 - 1. Electrical rough-in including circuit breaker or fused mainline switch with feeders to the controller, mounted on wall adjacent to dumbwaiter controller.
 - 2. Lights (with switches) and outlets in machine and deflector sheave areas and connection to studs on controller.
 - 3. Supports for guide rail brackets.
 - 4. Construction of hoistway.

1.02 QUALITY ASSURANCE

- A. Approved Manufacturers:
 - 1. Dumbwaiter Equipment: D. A. Matot Co., Atlas Dumbwaiter Co., Energy Elevator Co., or approved equal.
 - 2. Doors: Peelle Co., Security Door Co., manufacturer of dumbwaiter equipment.
- B. Dumbwaiter Installer's Maintenance Qualifications:
 - 1. The Dumbwaiter Installer shall be able to show evidence of successful experience in complete maintenance of dumbwaiters.
 - 2. The Dumbwaiter Installer shall directly employ sufficient competent personnel to handle the service locally.
 - 3. The Dumbwaiter Installer shall command local stock of parts adequate for replacement on permanent or emergency basis.
 - 4. The Dumbwaiter Installer shall be able to offer Owner agreement for continuing maintenance after expiration of maintenance period provided under this Contract.
- C. Requirements of Regulatory Agencies:
 - 1. Codes: Material and workmanship shall be in accordance with the latest applicable edition requirements of the following and as specified.
 - a. ASME: A17.1; Safety Code for Elevators and Escalators.
 - b. CCR: Titles 8 & 24; California Code Regulations.

- c. NEC: National Electric Code.
- d. UBC: Uniform Building Code.
- e. All local codes which govern.
- f. Requirements of the Office of Statewide Health Planning and Development and the Office of the State Architect (OSHDP/OSA) as applicable to hospitals.

1.03 SUBMITTALS

- A. Submit in accordance with Section "Submittals" and as required by Architect.
- B. Manufacturer's literature describing products.
- C. Shop Drawings: Show arrangement of equipment, clearances required, detail of cars, entrances and controls, attachment of equipment to building, sound control measures, requirements of related work specified elsewhere and all reactions.
- D. Samples: Exposed steel for color selection and approval of finish.
- E. Certificates: Submit certificates of compliance with standard designated and governing codes.

1.04 PRODUCT HANDLING AND DELIVERY: Discharge material carefully and store on clean concrete surface or raised platform in safe, dry area. Do not dump onto ground.

1.05 JOB CONDITIONS: Protect equipment and exposed finishes during construction against damage.

1.06 WARRANTY: Provide special project warranty, signed by Contractor, Installer and Manufacturer, agreeing to replace/repair/restore defective materials and workmanship of dumbwaiter work which may develop within one (1) year from final date of completion and acceptance of the entire installation. "Defective" is hereby defined to include, but not by way of limitation, operation or control system failures, performances below required minimums, excessive wear, unusual deterioration or aging of materials or finishes, unsafe conditions, the need for excessive maintenance, abnormal noise or vibration, and similar unusual, unexpected and unsatisfactory conditions.

1.07 ALTERNATES

~~A. Alternate No. 1; Continuing Full Maintenance Contract:~~

~~1. Quote cost and submit manufacturer's proposal for full maintenance contract for a period of five (5) years after expiration of 12 month maintenance provided with this new installation.~~

~~2. Provide examinations, replacements and call-back service as specified for maintenance under this Section.~~

PART 2 - PRODUCTS

2.01 DESCRIPTION OF SYSTEMS

A. Dumbwaiter No. 1

- | | |
|-----------------------|-----------------------------|
| 1. Quantity: | 1 |
| 2. Type: | Drum |
| 3. Loading: | Counter height |
| 4. Capacity: | 25 Pounds |
| 5. Speed: | 50 FPM |
| 6. Stops: | 2 |
| 7. Openings: | 1 Front 1 Rear |
| 8. Travel: | As Shown |
| 9. Machine Location: | Above |
| 10. Operation: | Call and Send |
| 11. Car Size: | 1'-3" W by 1'-3" D by 2'-6" |
| 12. Door Size & Type: | 1'-3" W by 2'-6" H |
| 13. Door Type: | Manual Bi Parting |

A. Entrances: Stainless steel doors, frames and sills.

B. Car Enclosure: Stainless steel with vertical lift bi-parting gate and removable shelves.

C. Signals:

1. Call and send push buttons at each floor.
2. Car arrival light and chime at each floor.

D. Miscellaneous Items:

1. Access doors to machine space.
2. Call bell on car when hoistway door is open and button is pressed.
3. Self-supporting steel tower.

2.02 MATERIALS

A. Sheet Steel: ASTM A366, uncoated, pickled, free from defects.

B. Stainless Steel: ASTM A167, type 302 or 304.

2.03 FINISHES

A. Exposed-to-View Surfaces:

1. Sheet Steel:

- a. Shop Prime: Degrease clean of foreign substances and apply one coat of corrosion inhibiting primer compatible with finish paint selected. Hoistway items visible to public shall be painted one additional coat of black paint.
 - b. Finish Paint: Three coats baked enamel of type and color as selected. Sand each coat smooth.
- 2. Stainless Steel: Satin directional polish, No. 4 finish unless otherwise specified.
- 3. Touch-Up:
 - a. Prime Surfaces: Use same paint as factory for field touch-up.
 - b. Finish Painted Surfaces: Refinish whole panel with shop prime and finish paint as specified above.
- B. Non-Exposed-to-View Surfaces: Degrease and shop paint manufacturer's standard corrosion inhibiting primer.

2.04 OPERATION

- A. Call and Send:
 - 1. Provide call and send operation with a push button station at each level consisting of a call button and a button for each floor served. It shall be possible to call the car or send it to any other level. Momentary pressure on a push button shall cause the car to move to the selected level. Call bell shall sound when hoistway door is open and button is pressed.
 - 2. Car shall travel upon call or dispatch provided doors are closed and locked.
 - 3. Buttons shall be inoperative when car is in travel and for a few seconds after arrival to permit time for opening door.
 - 4. Door shall not open without presence of car behind door.
 - 5. Limit switches shall be provided to bring car to automatic stop at terminal landings independent of regular operating devices.

2.05 MACHINE ROOM AND HOISTWAY EQUIPMENT

- A. Machine: Electric drum traction type. Locate at top of hoistway.
- B. Brakes: Magnet, shoe type, spring applied and electrically released.
- C. Motors: Elevator type with high starting torque and low starting current, alternating current.
- D. Machine and Motor Bearings: Anti-friction type.
- E. Controller: Suitable for specified operation and current. Complete with necessary operating switches, three overload relays and reverse phase relay. Wall mounted controller adjacent to machine area as directed.

- F. Guide Rails: As standard with manufacturer. Dumbwaiter components shall be carried on a self-contained, rigidly braced, structural steel tower, extending the full height of the hoistway.
- G. Hoist Ropes: Traction steel of proper number and size.
- H. Bumpers in Pit: Spring type.
- I. Electrical Items: Conductors, conduit, metal boxes, troughs, ducts, etc., shall conform to NEC. Provide all necessary wiring, 10% spare wires, a minimum of two, in all conduits and traveling cables.
- J. Provide machine and overhead access doors complete with self-closing and locking hardware and contacted.

2.06 SIGNALS AND FIXTURES

- A. Call and Send Station: Provide pushbutton stations at each opening consisting of a call button and a pushbutton for each floor served.
 - 1. Door open call buzzer shall be mounted on the car and shall sound automatically when a push button is pressed and a hoistway door or a car gate is open.
 - 2. Car arrival light and chime shall be recessed in the head trim of the hoistway door. Arrival of the car shall operate both the single stroke chime and the light. The light will extinguish when the hoistway door is opened.
 - 3. Combination door open and in use light: Each push button station shall have a pilot light marked "in use" on each push button station. Light will illuminate when car is in transit, and when a push button is pressed and a hoistway door or a car gate is open.
 - 4. Car Arrival Light and Chime: Car arrival lights and chimes shall be provided at each floor mounted above hoistway door.

2.07 CAR ENCLOSURE

- A. Stainless steel, 14 gauge, rigidly constructed. Complete with concealed car lights and non-ferrous guide shoes. Car gate manually operated, vertical lift bi-parting type, stainless steel, contacted.
- B. Provide 1 removable shelf.

PART 3 - EXECUTION

3.01 GENERAL: Bidding Documents: Bidders shall examine architectural, structural, electrical and mechanical plans and specifications. Any discrepancies which affect the dumbwaiter work or conditions adverse to the bidder's equipment shall be brought to Architect's attention at least seven (7) days prior to the bid date. If no discrepancies are presented, changes required to accommodate bidder's equipment becomes the responsibility of and cost to Contractor.

3.02 PREPARATION

- A. Field Measurements: Field verify dimensions before proceeding with the work. Coordinate related work by other trades. Verify the following to be acceptable for installation of

dumbwaiters.

1. Hoistway has been correctly sized and otherwise properly prepared.
2. Equipment supports are satisfactory.
3. Electrical rough-ins are correct.
4. Do not begin installation until unsatisfactory conditions have been corrected.

3.03 INSTALLATION

- A. General: Install per manufacturer's requirements, those of regulatory agencies and as specified.
- B. Welded Construction: Provide welded connections for installation of dumbwaiters work where bolted connections are not required for subsequent removal or for normal operation, adjustments, inspection, maintenance and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.
- C. Sound Isolation: Mount rotating and vibrating equipment and components on vibration-absorption mounts, designed to effectively prevent transmission of vibrations to structure and thereby eliminate sources of structure-borne noise from system.
- D. Lubricate operating parts of systems, including ropes, as recommended by manufacturer.
- E. Alignment: Coordinate installation of hoistway entrances with installation of guide rails, for accurate alignment of entrances with cars. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe workable dimensions at each landing.
- F. Erect guide rails plumb and parallel with maximum deviation of 1/16 inch. Anchorage of guide rails in pits shall not compromise waterproofing.
- G. Grout sills with non-staining, non-shrink grout. Set units accurately aligned with finished landing levels.

3.04 FIELD QUALITY CONTROL

- A. Regulatory Agencies Inspection: Upon completion of dumbwaiter, Contractor shall provide instruments, weights and personnel to conduct test required by regulatory agencies. The Contractor shall submit a complete report describing the results of the tests.
- B. Examination and Testing: When installation is ready for final acceptance, notify and assist Owner in making a walk-through inspection of entire installation to assure workmanship and equipment complies with contract documents.
- C. Correction: Make corrections to defects or discrepancies at no cost to Owner. Should discrepancies be such that re-examination and retesting are required, all costs, including those of Owner's representative fees, shall be paid for by the Contractor.
- D. Final Acceptance: Final acceptance of the installation will be made only after all corrections are complete, final submittals and certificates received and the Owner is satisfied that the installation is complete in all respects. Final payment will not be made until the above is

accomplished.

3.05 INSTRUCTIONS: Instruct Owner's personnel in proper use of system.

3.06 MAINTENANCE

- A. General: Provide complete continuing maintenance on entire dumbwaiter equipment during regular working hours on regular working days for a period of 12 months after filing Notice of Completion.
- B. Examinations: Include systematic examination once a month, adjustment and lubrication of equipment whenever required and replacement of defective parts with parts of same manufacture as required for proper operation. Contractor not responsible for repairs to car enclosures, door panels, frames, sills or platform flooring resulting from normal usage or misuse, accidents and negligence for which Contractor is not responsible.
- C. Maintenance Data: After completion and prior to final acceptance, submit three (3) sets of complete and accurate maintenance data specific for each dumbwaiter. Final payment will not be made until received.
 - 1. Manuals: Describe proper use and maintenance of equipment, lubrication points, types of lubricants used and frequency of lubricant application.
 - 2. Parts Catalogs: Complete listing of all parts of equipment and components used in the installation.
 - 3. Wiring Diagrams: One reproducible mylar set and two blue line sets delivered to Owner. Wiring diagrams shall be as built, specific for this installation, and reference identification on drawings shall match points identified on terminals of controllers.
- D. Final Service and Inspection: Two weeks before expiration of the year's maintenance the equipment shall be lubricated, fully serviced and adjusted. A complete inspection will be made by a representative of the Owner.
- E. Quotation: Base bid shall include cost of maintenance and materials as described above.

END OF SECTION

SECTION 14 24 00

ELEVATORS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Related Documents: Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections apply to this Section.
- B. Work Included in This Section: Provide hydraulic elevators complete as shown and specified.
- C. Related Work Interfaced With This Section:
 - 1. Life Safety, Muzak or Public Address Speakers: Furnished by others; wire from machine room to car, accommodations and installation in car canopy by this Section.
 - 2. Card Readers: Furnished by others; wire from machine room to car, interfacing with elevator controls and installation in elevator car by this Section. Connection in machine room and testing by others.
 - 3. Close Circuit T.V.: Furnished by others; wire from machine room to elevator car by this Section. Connection in machine room and testing by others.

1.02 QUALITY ASSURANCE:

- A. Qualifications of Bidders:
 - 1. General: The entire elevator installation shall be manufactured, installed and maintained by an acceptable manufacturer listed or as qualified by addendum. No portion of the work shall be subcontracted unless qualified and accepted by addendum. Equipment proposed must have a history of successful operation under similar conditions for the last two (2) years.
 - 2. Acceptable Bidders: One of the following or as approved by addendum. Those not listed must pre-qualify ten (10) days prior to bid date. Submit list of at least three (3) projects representing equivalent equipment that has been operational for at least two (2) years. Include Owner's name, person to contact and telephone number.
 - a. Mitsubishi Elevator Company.
 - b. Otis Elevator Company.
 - c. ThyssenKrupp Elevator Company.
 - 3. Maintenance Qualifications: Performed by manufacturer installing elevator:
 - a. Show evidence of successful experience in complete maintenance of elevators.
 - b. Directly employ sufficient competent personnel within 50 miles of project to handle service.
 - c. Maintain local stock of parts adequate for replacement on permanent or emergency basis.
 - d. Respond to trouble calls within one hour.
 - e. Offer the Owner agreement for continuing maintenance after expiration of maintenance period under this contract.
 - 4. Elevator Cars and Entrances: One of the following or accepted equal:
 - a. Elevator Manufacturer.
 - b. Hauenstein and Burmeister.
 - c. Tyler Elevator Products.
- B. Requirements of Regulatory Agencies:

1. Codes: In accordance with the latest applicable edition requirements of the following and as specified:
 - a. A.D.A.: Americans with Disabilities Act.
 - b. ASME: American Society of Mechanical Engineers - A17.1; Safety Code for Elevators and Escalators.
 - c. CBC: Title 24; California Building Codes.
 - d. CCR: Titles 8; California Code of Regulations.
 - e. NEC: National Electric Code.
 - f. IBC: International Building Code.
 - g. All local codes, which govern.
 - h. Requirements of the Office of Statewide Health Planning and Development (OSHPD). Refer to "SUBMITTALS" for deferred approval for hospitals.
2. Permits: Arrange and pay for inspections by governing authorities and obtain all required operating permits.

1.03 SUBMITTALS:

- A. Shop Drawings: Submit as required by the Owner's Representative. The Owner's Representative reserves the right to require any details of any portion of the equipment.
 1. Layouts: Plan and section of hoistways, pits and machinery spaces; include impact and static loads imposed on building structure location of hoistway ventilation and required clearances around equipment.
 2. Details: Submit details of cabs, fixtures and entrances.
 3. Data: Indicate on layouts or separate data sheets; machine spaces heat release, power requirements, normal annual power consumption, conduit runs outside of hoistways and machine rooms, car and counterweight roller guides and door operators.
- B. Samples: Provide samples of materials and finishes exposed to public view and additional, if specifically requested, 6 inch x 6 inch panels, 12 inch lengths or full size if smaller, as applicable.
- C. Operating Instructions: Submit manufacturer's literature describing system operations and special operations as specified.
- D. OSHPD Deferred Approval: Submit the following to Owner's Representative and Engineer for approval prior to submitting to OSHPD for approval.
 1. Provide minimum of 15 pounds per foot guide rails or heavier.
 2. Provide minimum 3/8 inch thick steel for guide rail brackets or heavier.
 - a. Submit details showing bracket support spacing and method of attachment.
 - b. Submit splice plate details with locations at a maximum of 20% of span from support bracket.
 - c. Submit details of guide shoe retainer plates located under guide shoes on top and bottom of counterweight and car.
 - d. Submit details of machinery tie-down supports.
 - e. Submit calculations justifying the above design prepared and signed by Structural Engineer registered in the State of California.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Protect equipment during transportation, erection and construction. Store under cover to prevent damage due to weather conditions. Replace damaged materials.

1.05 SEQUENCING AND SCHEDULING:

- A. Schedule and be responsible for coordinating related work with other trades to avoid omissions and delays in job progress.

1.06 WARRANTY:

- A. Provide special project warranty, signed by Contractor, Installer and Manufacturer, agreeing to replace/repair/restore defective materials and workmanship of elevator work which may develop within one (1) year from final date of completion and acceptance of the entire installation. "Defective" is hereby defined to include, but not by way of limitation, operation or control system failures, performances below required minimums, excessive wear, unusual deterioration or aging of materials or finishes, unsafe conditions, the need for excessive maintenance, abnormal noise or vibration and similar unusual, unexpected and unsatisfactory conditions.

1.07 ALTERNATES:

~~A. Alternate No. 1; Continuing Full Maintenance Contract:~~

- ~~1. Quote cost and submit manufacturer's proposal for full maintenance contract for a period of contract for a period of five (5) years after expiration of 12-month maintenance provided maintenance provided with this new installation.~~
- ~~2. Provide weekly examinations, lubrication and replacements in accordance with manufacturer's manufacturer's standard practice. Include a minimum of one and one-half hour per traction hour per traction elevator and one-half hour per hydraulic elevator per visit performing only performing only preventative maintenance. Any work required performing repairs or performing repairs or answering trouble calls shall be in addition to the preventative to the preventative maintenance hours.~~
- ~~3. Provide 24-hour emergency call back (entrapments) service and trouble callbacks after hours during normal working hours at no cost to Owner. Trouble callbacks after hours shall be callbacks after hours shall be billable for the premium time portion only.~~

PART 2 - PRODUCTS:

2.01 DESCRIPTION OF SYSTEMS:

- | | |
|-------------------------------|--|
| A. Elevator No. 1 | Service |
| 1. Type: | Hydraulic Direct Plunger |
| 2. Capacity: | 4500 Pounds |
| 3. Speed: | 125 FPM |
| 4. Stops: | 3 |
| 5. Openings: | 3 In Line |
| 6. Travel: | 28'-6" As Shown |
| 7. Control: | SCR Soft Start |
| 8. Operation: | Simplex Selective Collective Operation |
| 9. Machine Location: | Adjacent |
| 10. Special Operations: | |
| a. Independent Service | |
| b. Fire Emergency Service | |
| c. Tenant Security | |
| d. Emergency Battery Lowering | |
| 11. Car Enclosure Type: | Service |
| a. Platform Size | 6'-0" W by 8'-9 D by 10'-0" H |
| b. Inside Clear | 5'-8" W by 7'-10" D by 10'-0" H |

12. Signals and Fixtures
 - a. Car Operating Panels Vandal Resistant
 - b. Car Position Indicator 1 Per Car; Applied Type
 - c. Communication Sys. Integral with Each Car Panel
 - d. Service Cabinet Integral with Car Panel
 - e. Hall Pushbuttons 1 Riser
 - f. Hall Lanterns All Floors
 - g. Hall Pos. Indicators All Floors
13. Passenger Entrance Type Side Open, Two Speed
 - a. Size 4'-0" W by 7'-0" H
 - b. Frames Ferritic Stainless Steel
 - c. Doors Stainless Steel
 - d. Sills Aluminum
14. Miscellaneous Items:
 - a. Disabled Access Requirements
 - b. Key Operated Hoistway Access
 - c. Earthquake Requirements
 - d. Card Reader Provisions
 - e. Oil Cooler
 - f. CCTV Provisions
 - g. OSHPD Requirements
- B. Elevator No. 2 - 3 Service
 1. Type: Hydraulic Direct Plunger
 2. Capacity: 4500 Pounds
 3. Speed: 125 FPM
 4. Stops: 3
 5. Openings: 2 Front 1 Rear
 6. Travel: 28'-6" As Shown
 7. Control: SCR Soft Start
 8. Operation: Duplex Selective Collective Operation
 9. Machine Location: Remote
 10. Special Operations:
 - a. Independent Service
 - b. Fire Emergency Service
 - c. Tenant Security
 - d. Emergency Battery Lowering
 11. Car Enclosure Type: Service
 - a. Platform Size 6'-0" W by 10'-9 1/4" D by 10'-0" H
 - b. Inside Clear 5'-8" W by 7'-11" D by 10'-0" H
 12. Signals and Fixtures Vandal Resistant
 - a. Car Operating Panels 2 Per Car; Applied Type
 - b. Car Position Indicator Integral with Each Panel

- c. Communication Sys. Integral with Car Panel
- d. Service Cabinet Integral with Car Panel
- e. Hall Pushbuttons 1 Riser
- f. Car Lanterns Dual Each Entrance
- 13. Passenger Entrance Type Side Open, Two Speed
 - a. Size 4'-0" W by 7'-0" H
 - b. Frames Ferretic Stainless Steel
 - c. Doors Stainless Steel
 - d. Sills Aluminum
- 14. Miscellaneous Items:
 - a. Disabled Access Requirements
 - b. Key Operated Hoistway Access
 - c. Earthquake Requirements
 - d. Card Reader Provisions
 - e. Oil Cooler
 - f. CCTV Provisions
 - g. OSHPD Requirements

2.02 MATERIALS:

- A. Aluminum: Alloy and temper best suited for anodizing finish specified.
- B. Glass: Laminated Safety Glass meeting ANSI Z97.1.
- C. Nickel Silver: CDA Alloy 796, leaded nickel silver.
- D. Plywood: PS-1, A-D exterior Grade Douglas Fir, fire retardant treated.
- E. Sheet Steel: ASTM A366, uncoated, pickled, free from defects.
- F. Sound Deadener: Fire retardant; spray, roller or adhesive applied; 3/16 inch thick.
- G. Stainless Steel: ASTM A167; type 302, 304. ASTM A240

2.03 FINISHES:

- A. Exposed-to-View Surfaces. Provide as follows unless otherwise specified.
 - 1. Aluminum: Clear anodized finish.
 - 2. Sheet Steel:
 - a. Shop Prime: Degrease clean of foreign substances and apply one coat of corrosion inhibiting primer compatible with finish paint selected. Hoistway items visible to public shall be painted one additional coat of black paint.
 - b. Finish Paint: Factory applied baked enamel or powder coat; color as selected.
 - 3. Stainless Steel:
 - a. Plain: Satin, directional polish, No. 4 finish unless otherwise specified.
 - b. Patterned: Rigidized Metal's No. 5 WL, RIMEX Metals No. 5-SM or equal.
 - c. Entrances shall be ferritic stainless steel (magnetic) to allow use of Smoke Guard product at each landing entrance. ASTM A240
 - 4. Touch-Up:
 - a. Prime Surfaces: Use same paint as factory for field touch-up.
 - b. Finish Painted Surfaces: Refinish whole panel with shop prime and finish paint as specified above.

- B. Non-Exposed-to-View Surfaces: Degrease and shop paint manufacturer's standard corrosion inhibiting primer.

2.04 AUTOMATIC OPERATION:

A. General Operation of Individual Elevators:

1. Provide a non-proprietary microprocessor-controlled system.
2. Pre-Approved Products:
 - a. ThyssenKrupp TAC 20
 - b. Otis Elevonic 211
 - c. Motion Control Engineering HMC-2000
3. Fault Diagnostic System: Provide Owner with all hardware such as on-board LED. Diagnostics, hand held device or laptop computer, as standard with manufacturer, and supporting software documentation. Diagnostic system shall be capable of determining faults most difficult to find.

B. Simplex Selective Collective Operation:

1. Provide a microprocessor-based control system to perform functions of elevator motion, car operation dispatching and door control.
2. Arrange for Simplex Selective Collective automatic operation. Operate elevators from a single riser of landing buttons and from operating device in car.
3. Momentary pressure of one or more car or landing buttons, other than those for landing at which car is standing, starts car, and causes car to stop at first landing for which a car or landing call is registered corresponding to direction in which car is traveling. Stops made in order in which landings are reached, irrespective of sequence in which calls are registered.
4. Double door operation not permitted. If an up traveling car has a passenger for an intermediate floor and a down call is registered at that floor, with no calls above car, it travels to floor, opens door to let passenger out, then lights down direction arrow in hall lantern and accepts waiting passenger without closing and reopening doors.

C. Two-Stop Collective Operation:

1. Provide a microprocessor-based control system to perform functions of elevator motion, car operation dispatching and door control.
2. Operate elevator from single button landing stations and operating buttons in car.
3. Landing or car button causes car to start and proceed to that floor. Doors open automatically when car arrives. When car is traveling away from a registered landing call, call remains registered and car responds on next trip.

2.05 SPECIAL OPERATIONS:

- A. Inspection Operation: Provide key-operated hoistway access device and car top operating device. Key switches shall be mounted in doorframes with only ferrule exposed at terminal landings. Incorporate access switches in hall button stations for freight elevators.
- B. Independent Service: Independent service operation shall be provided so that, by means of a switch located in the car service cabinet, the car can be removed from automatic operation and be operated by an attendant. The attendant shall have full control of the starting, stopping and direction of car travel. The car shall respond to car buttons only. The hall signals for the car on independent service shall not operate.
- C. Operation Under Fire or Other Emergency Conditions: Provide special emergency service to comply with ASME A17.1, CCR Title 8, IBC, UBC and local codes having jurisdiction. Provide Phase 1 recall switch at Main Floor Elevator Lobby and Fire Control Life Safety Room. Interlock recall switches to prevent simultaneous activation. Key switches at main floor shall be integrated in hall button station with engraved instructions.
- D. Tenant Security: Provide means in control system to enable and disable car call buttons as

follows:

1. Function, which locks out all cars in a group so that all car buttons are inoperative, except the main floor.
2. Function which locks out any selected car button for all elevators in a group serving that floor.
3. Tenant security operations can be overridden by cars on independent, any special emergency service or by card reader access.

2.06 DOOR OPERATION:

A. Passenger Type Horizontal Sliding:

1. Door Operator: Provide heavy-duty master type operators with direct current motor. Provide closed-loop door operators, equal to Otis AT-400 or I-Motion, ThyssenKrupp HD04, Mitsubishi LV4K, or GAL-MOVFR.
 - a. Provide door times available as specified under "Design Criteria".
 - b. Car and hoistway doors shall open and close simultaneously, quietly and smoothly; door movement shall be cushioned at both limits of travel. Door operation shall not cause cars to move appreciably.
 - c. Door hold open times shall be readily and independently adjustable when car stops for a car or hall call. Main floor door hold times shall be adjustable independent of other floors.
2. Hangers and Tracks: Sheave type with two-point suspension. Steel sheaves with flanged groove and resilient sound-absorbing tires. Minimum 2-1/2 inch diameter for hoistway, 3 inch for car. Manufacturer's heavy-duty tracks and ball or roller bearing with adjustable up thrusts.

B. Door Protection; Passenger Type:

1. Electronic Scanning Type:
 - a. Provide a door protective system, which does not rely on physical contact with a person or object to inhibit door movement or initiate door reversal. Provide system equal to the Otis "Lambda II", Adams "I.C.U." or Janus "Panaforty".
 - b. The system shall be able to detect a 2-inch diameter rod introduced at any position within the door movement and between the height of 2 inches and 63 inches above sill level.
 - c. Detection of intrusion into the protected area shall cause the doors, if fully open, to be held in the open position and, if closing, to reverse to fully open position.
 - d. If doors are prevented from closing for an adjustable period of 15 to 45 seconds or upon activation of Fire Emergency Service, they shall proceed to close at reduced speed and a loud buzzer shall sound. Door closing force shall not exceed 2-1/2 ft.-lbs. when door re-opening device is not in operation.
 - e. For side-opening doors, the detector for the strike jamb side shall be recessed, flush with strike jamb.
2. Door Hold Button; Service Elevators: Provide an illuminated door hold button, operation of which will hold the doors open for a predetermined and adjustable period of 20 to 90 seconds. Sound warning buzzer 5 seconds prior to expiration of time. Normal operation shall be resumed upon:
 - a. Expiration of door hold time.
 - b. Operation of door close button in car.
 - c. Operation of any floor button in car.

- ### C. Interlocks: Equip each hoistway door with a tamper-proof interlock, which shall prevent operation of the car until doors are locked in the close position as defined by the Code. Interlock shall prevent opening of doors at landing from corridor side unless car is at rest at

landing, is traveling through leveling zone or, hoistway access switch is used. Interlocks shall lock the two door sections together.

2.07 SIGNALS AND OPERATING FIXTURES:

- A. General: Provide signals and fixtures as shown and specified. Location and arrangement of fixtures shall comply with handicap requirements.
 - 1. Service and Freight Elevator Buttons: Provide vandal-resistant stainless steel minimum 1 inch diameter mechanical buttons, raised 1/8 inch from surrounding surface with square shoulders and integral illumination equal to Adams, EPCO or GAL fixtures. Operation of car or hall button shall cause button to illuminate. Response of car to car or hall call shall cause corresponding button to extinguish.
 - 2. Switches: Toggle type typically or key operated where noted.
 - 3. Faceplates: Provide of material and finish as indicated and specified; 1/8 inch minimum thickness with sharp edges relieved. Unless otherwise specified provide stainless steel faceplates.
 - 4. Fastenings: Provide with flush tamper-proof screws of material and finish matching faceplates.
 - 5. Cabinets: Provide with pulls, concealed hinges and doors mounted flush with hairline joints to adjacent surface.
 - 6. Arrangement: Arrangement of fixtures shall generally conform to that specified, but components may be rearranged, if desired, subject to Owner's Representative's approval.
 - 7. Engraving: Of size indicated; color backfill with epoxy paint in contrasting color as selected.
 - 8. Lamps: Miniature LED type.
 - 9. Audible Chimes: Electronic adjustable audible chimes; bell type gong not acceptable.
 - 10. Provide floor passing signal of the adjustable electronic audible chime type.
 - 11. Tactile Markings: Provide raised Braille and alpha characters, numerals or symbols to the left of operating buttons and devices used by the public. Indications may be engraved directly on faceplates or separate plates flush mounted with hairline joints and concealed mechanical fasteners. Plates shall be of same size and shape as buttons.
- B. Car Operating Panels:
 - 1. General: Provide buttons numbered to conform to floors served and the following:
 - a. Locate top operating button at 48 inches above floor; maximum 54 inches when required.
 - b. Locate emergency stop and illuminated alarm button in bottom row at 35 inches above floor. Wire emergency stop to ring alarm bell.
 - c. Provide "Door Open", "Door Hold", and "Door Close" buttons located above emergency stop and alarm of same design as car button.
 - d. Engrave main panel with capacity, number of passengers and elevator number in 1/4-inch letters. Engrave auxiliary panel with NO SMOKING in 1-inch letters. All other signage required by local codes shall be engraved as directed by Owner's representative.
 - e. Provide fire emergency panel above floor buttons containing phase II fire key switch, call cancel button stop switch, door open, door close buttons, audible/visual signals and instructions.
 - f. Make provisions for card readers in Elevator No. .
 - 2. Applied Type: Integrate cabinets, buttons and engraving into hinge single piece faceplate mounted to front return panel or sidewall adjacent to strike jamb.
- C. Car Position Indicators:

1. Provide alpha numeric segmented digital type direct readout indicator with minimum two-inch high indications mounted integral with each car-operating panel.
- D. Hall Position Indicators: Digital type with 2-inch high indications.
- E. Service Cabinet: Provide cabinet door with a lock and concealed hinge as an integral part of car operating panel mounted with flush hairline joints. Cabinet door shall be provided with a flush glazed window of required size to hold elevator-operating permit. Service cabinet shall contain the following:
1. Independent service switch.
 2. Two-speed ventilation switch.
 3. Light switch or dimmer as applicable.
 4. Inspection switch, key operated.
 5. Duplex convenience outlet.
 6. Buzzers as required.
 7. Constant pressure test switch for emergency car lighting.
 8. Card reader over-ride switch-key operated.
- F. Passenger Emergency Communication Speaker Phone: Provide a complete communication system in compliance with A.D.A. regulations consisting of a combination speaker/microphone, amplifier, automatic dialer with 4 number rollover capability and matching car station push button with telephone symbol to activate system and call-acknowledgement lights. Mount behind a pattern of holes as selected as an integral part of car operating panel. Wire to machine room and program automatic dialer as directed by Owner.
- G. Building Emergency Personnel Communication System (for Travels over 60'): Provide a two-way voice communication system in accordance with ASME A17.1. The two-way voice communication system outside of the car shall be located within the hospital switchboard.
- H. Hall Button Fixtures: Each fixture shall contain buttons, which light to indicate hall call registration and extinguish when call is answered. Engrave fire-exiting instructions on faceplates.
- I. Car Lanterns: Vandal resistant dual car riding lanterns mounted at a maximum height above floor. Lens shall be flush with faceplate or face of jamb. Lantern illuminates and chimes as doors open. Provide single chime for up direction and double chime for down direction.

2.08 WIRING:

- A. General: Provide all necessary wiring with 15% or a minimum of four spares between cars and controllers and to all remote control stations. Furnish shielded wires in cables for all communication systems card readers and speakers. Include two additional pairs of shielded spares for each car.
- B. Traveling Cables: Use minimum number of traveling cables with flame retarding and moisture resisting covers. Include shielded wires and spares as noted above. Cord thoroughly and protect cables from rubbing against hoistways or car items. Provide with steel cable core and properly anchored to relieve strain on individual conductors.
- C. Work Light and Convenience Outlet: Provide on top of car with wire lamp guard.
- D. Stop Switch: Provide in each pit and on top of car.
- E. Alarm Gong: Six-inch size, 110 volt. Provide on top of each car to be actuated by corresponding alarm button or emergency stop switch.
- F. Auxiliary Disconnect Switches: Provide as required in remote controller rooms or at remote equipment not in view of mainline switches; include all wiring and conduit.
- G. Coaxial Circuit: Provide for closed circuit television camera in elevators. Run from elevator car to machine room.

2.09 CAR ENCLOSURES:

- A. General: Fabricate finish work smooth and free from warps, buckles, squeaks and rattles; joints lightproof. Car shall be sound isolated from car frame. Apply outside of car with 3/16-inch thick sound deadener. No visible fastenings, except as indicated.
- B. Service/Passenger Cars; Elevator No. 1-2:
 - 1. Steel Shell: Fabricate walls of 14 gauge patterned stainless steel. Extend from floor to canopy and heavily reinforce to withstand severe service.
 - 2. Canopy and Lighting: 12 gauge reinforced stainless steel with recessed fluorescent light fixtures with protective lens. Protect light housing from damage.
 - 3. Emergency Exit: Top of car per code.
 - 4. Car Doors: Fabricate from 16-gauge sheet steel on front and back of each panel sufficiently reinforced with steel to insure rigidity and sound deadened. Provide two guides per panel located one inch from each end. Provide full-length neoprene astragals. Mount doors on structural header, not on car enclosure. Finish car side with stainless steel and return finish 1/2 inch around edge of doors.
 - 5. Entrance Columns and Front Return: Provide front return panels fabricated from 14 gauge stainless steel.
 - 6. Ventilation: two-speed squirrel cage exhaust blower, Morrison model AA or equal, with sound isolation mounting on canopy. Provide vent slots in base.
 - 7. Bumper Rails: Provide 1/2 inch by 6-inch stainless steel No. 4 finish bar located at 12 inches above floor on all walls without entrances. Mount flat with countersunk mechanical fasteners securely attached to car shell.
 - 8. Handrail: Provide a 1-1/2 inch diameter stainless steel rail on all walls without entrances mounted with matching brackets securely attached to car shell.
 - 9. Sills: Provide extruded aluminum threshold plate. Mount with concealed mechanical fasteners. Allow for installation of finish flooring.
 - 10. Finish Flooring: 1/8" thick aluminum diamond plate flooring.
- C. Service / Passenger Car; Elevator No. 3:
 - 1. Steel Shell: Fabricate walls of 14-gauge sheet steel from floor to canopy. Canopy 12 gauge reinforced. Paint shell in color as selected by Owner's Representative.
 - 2. Emergency Exit: Top of car per code.
 - 3. Ventilation: Two-speed squirrel cage exhaust blower, Morrison model AA or equal, with sound isolation mounting on canopy. Provide concealed vents above base and ceiling as required.
 - 4. Car Doors: Fabricate from 16-gauge sheet steel on front and back of each panel sufficiently reinforced with steel to insure rigidity. Provide two guides per panel located one inch from each end. Provide full-length neoprene astragals. Finish car side with stainless steel and return finish 1/2 inch around edge of doors.
 - 5. Protective Pads: Provide one set of heavy quilted protection pads for each group of elevators. Pads shall cover all walls with cutout sections for car operating panels. Provide pads with rubber-coated 'J' type hooks sewn into top of pad for mounting on top of removable panels.
 - 6. Front Return Panels: Provide fixed type front return panels fabricated from 14 gauge stainless steel.
 - 7. Interior Panels: Provide removable panels of 3/4-inch particleboard core with balance sheet; align joints with ceiling grid. Face and edge with plastic laminate as selected by Owner's Representative.
 - 8. Base and Metal Trim: Provide base below removable panels, vertical joints between panels and other metal fabricated from stainless steel.

9. Ceiling and Lighting: Provide a suspended ceiling fabricated from stainless steel No. 4 finish plastic laminate applied to particle board as shown. Provide equally spaced low voltage down lights in ceiling as shown with dimmer switch controls located in service cabinet. Install 10 inches below canopy.
10. Bumper Rails: Provide 1/2 inch by 6-inch stainless steel No. 4 finish bar located at 12 inches above floor on all walls without entrances. Mount flat with countersunk mechanical fasteners securely attached to car shell.
11. .
12. Handrail: Provide handrails on rear and side walls. Fabricate from 1-1/2 inch diameter stainless steel with matching brackets. Securely attached to car shell with concealed fasteners.
13. .
14. Sills: Provide extruded aluminum threshold plate. Mount with concealed mechanical fasteners. Allow for installation of finish flooring.
15. Finish Flooring: Vinyl tile as selected by Owner's Representative.
- D. Emergency Lighting; All Elevators: Provide an emergency car lighting unit mounted on top of car, battery driven and self-rechargeable. Upon outage of normal power the unit shall, within 5 seconds, light two lamps as part of normal car lighting or separate lights mounted above drop ceiling. The unit shall have sufficient capacity to keep the lights in continuous operation for four hours and also the alarm bell for one hour. Provide a readily accessible means for testing the unit in service cabinet. Light fixtures mounted in car front returns or operating panels are not acceptable.

2.10 HOISTWAY ENTRANCES; PASSENGER TYPE:

- A. General: Fabricate finish work smooth with flush surfaces and free from warps and buckles. Entrance assemblies shall bear 1-1/2 hour U.L. rating. Provide entrances of size and type as scheduled.
- B. Struts and Closer Angles: As required for entrance installation and door closer mechanism. Use full-length struts. Hanger headers, minimum 3/16 inch material extending from strut to strut.
- C. Dust and Hanger Covers: Provide as required of minimum 16-gauge sheet steel. Provide hanger cover plates extending full length of door track. Paint black.
- D. Fascia, Toe and Head Guards: Minimum 16 gauge sheet steel; reinforce fascia. Paint black. Provide blind fascia in express zones or for reverse openings as required.
- E. Sills: Extruded sills with non-slip surfaces and grooves suitable for guides. Extend strut to strut and mount without exposed screws. Provide all support angles and levelers for a complete installation. Sill material as scheduled.
- F. Frames: Fabricate from 14-gauge material with side jambs in one continuous piece from sill to head section. Standard bolted frame will be acceptable. Material and finish of frames as scheduled.
- G. Doors: Fabricate from 16-gauge material sufficiently reinforced with steel to insure rigidity and sound deadened. Provide two guides per panel, which will remain engaged in sill if guiding member is destroyed. Provide full-length neoprene astragals on leading edge and non-vision wings of material and finish to match doors. There shall be no keyholes in the door unless required by governing authority. Corridor side of door panel material and finish as scheduled. Return finish a minimum of 1/2 inch around edges of door.
- H. Tactile Markings: Provide raised Braille and alpha characters, numerals or symbols similar to those for car stations of size required by governing authority. Locate on each entrance jamb at 60 inches above floor indicating floor designation. Material and finish of plates shall have contrasting background and mounting means similar to those on car panels.

2.11 HYDRAULIC ELEVATOR EQUIPMENT:

A. Design Criteria:

1. Performance:

- a. Contract Speed: Maximum twenty percent (20%) speed variation under any loading condition in either direction.
- b. Motion Time: From start to stop of elevators motion as measured in both directions for a typical one floor run under any loading condition. Initiate movement of car within 1.5 second after make-up of hoistway door interlock. (Typical floor height of 12'-0")
 - 1) 125 FPM: 9.1 seconds.
- c. Door Open Times:
 - 1) 4'-0" Side Open: 2.5 seconds.
- d. Door Close Times: Minimum, without exceeding kinetic energy and closing force, allowed by code.
- e. Door Dwell Times: Comply with A.D.A. formula and provide separate adjustable timers with initial settings as follows:
 - 1) Hall Call: 6.0 to 8.0 seconds.
 - 2) Car Call: 5.0 to 6.0 seconds.
 - 3) Interruption of Door Protective Device: Reduce dwell to 1 second after all ADA requirements have been met.
- f. Leveling: Within 3/8 inch under any loading condition. Level into floor at all times, do not overrun floor and level back.
- g. Hydraulic Pressure: Hydraulic components shall be factory tested for 600 PSI. Maximum operating pressure shall be 425 PSI.

2. Operating Qualities: Owner's representative will judge riding qualities of cars and enforce the following requirements. Make all necessary adjustments.

- a. Starting and stopping shall be smooth and comfortable. Slowdown, stopping and leveling shall be without jars or bumps.
 - 1) Vertical Acceleration: Maximum 4 ft. per second squared. Maximum jerk 8 ft. per second cubed.
 - 2) Horizontal Acceleration: Maximum 10 mg peak-to-peak measured at full speed for full travel in both directions.
- b. Full Speed Riding: Free from vibration and sway.

3. Sound Control:

- a. Vibration: Sound isolate the power units from building structure to prevent objectionable noise and vibration transmission to occupied building spaces.
- b. Airborne Noise: Maximum acoustical output level of:
 - 1) 85 dba measured in machine room.
 - 2) 60 dba measured in elevator cars during all sequences of operation.
 - 3) 50 dba measured in elevator lobbies.

B. Guide Rails:

1. Size: Standard steel tees with backs machined for splice plates. Extend rails full depth of pits. Do not bottom on pit floor. Minimum weight shall be 15 pounds per foot.
2. Installation: Drawings indicate basic hoistway framing and special supports for rail brackets. Guide rails shall be sized or reinforced to span a distance of 14'-0". The Elevator Contractor shall provide all additional supports and/or rail backing required. Install plumb within 1/16 inch. File joints smooth.

C. Guide Shoes:

1. Roller Guides: Roller type with rubber composition tires, minimum 3/4 inch wide and adjustable spring loaded to provide continuous contact with rail surfaces. Nominal roller diameters shall be 6 inches.

2. Slide Guides: Provide heavy duty solid or swivel type sliding guides with non-metallic gibs requiring minimal lubrication; minimum 8 inches long.
- D. Buffers: Spring type mounted on cylinder support channels with required blocking and supports. For deep walk-in pits provide platforms with access ladders for servicing plunger assembly.
- E. Car Frame and Platform:
1. Service/Passenger Elevators: Freight type construction with heavy channels front and rear, metal stringers with steel or double layered wood floor. Design for Class A freight loading to carry a one-piece load on a small electric hand truck with a maximum 1/4-inch deflection. Assume wheelbase of 24 inches wide by 48 inches long.
- F. Platen Isolation: Provide minimum 3/4-inch thick steel plates between top of plunger and car frame with one inch rubber or neoprene isolation material between.
- G. Cylinder Well and Casing:
1. Well: The Elevator Installer shall familiarize himself with existing conditions and be responsible for drilling cylinder wells.
 2. Casing: Provide steel casing, 12 inches greater in diameter than wrapped cylinder and proper depth to retain hole and provide structural integrity of PVC casing. Provide minimum 10 gauge corrosion resistant well casing having minimum 0.2 percent copper content; watertight joints and closed bottom. Weld seams solid at multiple casing joints. Provide a steel ring at top of casing to be keyed into pit floor. Provide watertight seal at bottom using 2 feet 0 inches thick non-shrink concrete plug of type for installation under water where drive casing is required and closed bottom casing cannot be installed.
 3. Provide minimum 3/8 inch thick PVC casing with watertight sealed couplings and bottom end caps. Inside diameter shall be 6 inches greater than outside diameter of cylinder. Extend PVC above pit floor. Seal top of PVC and provide an inspection port of 2-inch diameter by 4-inch long PVC pipe with threaded cap.
 4. Installation: Set cylinder and PVC casing within steel casing. Backfill between hole and steel casing with natural soils the full height of hole. Backfill between PVC casing and steel casing with clean dry pea gravel at bottom 2'-0" of casing to stabilize PVC with casing. Plunger and cylinder shall be plumb within 1/16 inch.
- H. Cylinder: Steel pipe, factory tested for 600-pounds/square inch working pressure. Sandblast or wire brush outside of cylinder to remove rust and scale. Paint with heavy coat of epoxy or mastic. Wrap with 20-mil wrapping of Trantex, Tapecoat, Glasswrap or approved equal. Work shall be done in shop and repaired in field if coating is damaged.
- I. Plunger: Use seamless steel pipe or tubing, minimum Schedule 80. Plunger shall be no more than 0.010 inch out of round and straight within 1/16 inch. Protect during shipping and installation to avoid damage. If plunger is gouged, scarred or shows visible tool marks, it shall be replaced. Finish shall be 20 micro inches or finer. Plunger top shall be isolated from car frame. Plungers with follower guides are not acceptable.
- J. Packing: Provide packing, which inhibits leaking of oil with drip ring.
- K. Scavenger Pump: Provide electrically operated scavenger pump with storage reservoir and float activated or other automatic means to return oil to system. Provide 1/2 inch copper tubing for oil return line.
- L. Oil: Provide Hydro Safe biodegradable hydraulic vegetable oil or approved equal specifically designed and formulated for hydraulic elevator use.
- M. Piping: Minimum Schedule 80 steel pipe suitable for 600 pounds pressure. No hoses shall be used in any part of piping. Provide sound isolating couplings in oil line between jack and pumping plant. Support piping using vibration isolating mounts or hangers with integral felt or neoprene at least 1/4 inch thick. Use threaded or welded joints throughout except at the connections to power unit and cylinder unit. Use no more than two victaulic type connections in the machine room and two in the pit area.

1. Overhead and Exposed Piping: Provide drip deflectors at pipe joints where pipes run above ceiling areas to prevent damage to these areas in case of joint leakage.
 2. Underground Piping: Protect with extruded high density polyethylene coating having a thickness of 25 to 60 mills applied with a minimum 8 mill thickness of modified rubber adhesive material all as manufactured by Plexco or equal. Install piping on three-inch bed of clean, dry sand and backfill with additional three inches of sand.
 3. Testing: Before enclosing pipe system, close ends, fill with fluid, establish 600 PSI pressure and allow to stand for 24 hours. Make corrective repairs to leaks or pressure drop.
- N. Pit Valves:
1. Provide in each elevator pit a gate valve to shut off oil between cylinder and pumping plant.
 2. Provide a pressure type line rupture safety valve to shut off oil between cylinder head and pit valve. Activation of safety valve shall not void operation of lowering valve.
- O. Pumping Plant:
1. General: Self-contained unit with sound reducing cabinet and sound isolated base.
 2. Pump: IMO, Roper or accepted equal for 150 SSU oil, belt driven or submersible. Maximum speed 3600 RPM. Maximum pressure 425 pounds per square inch.
 3. Tank: Capacity equal to plunger displacement plus 25%. Provide strainers, oil level sight gauge and device to maintain uniform oil temperature.
 4. Valves: Integral type by Elevator Equipment Company, Maxton Company or by elevator manufacturer. Provide conveniently located manual lowering valve accessible without removing pumping plant enclosure panels.
 5. Motor: General Electric, Imperial, Westinghouse or accepted equal; maximum speed 1800 RPM for belt driven and 3600 RPM for submersible. Provide minimum 120 start heavy-duty motor, continuous rated, 50 degrees C. temperature rise, Class A insulation or 70 degrees C. rise for Class B insulation.
 6. Controller: Integral, floor or wall mounted as applicable to space conditions. Include door-operating relays combined with controller. Provide SCR solid-state soft start starting. Provide three (3) manual reset overload relays, one in each line and reverse phase relay. Provide externally mounted permanently identified junction boxes on controller cabinets for termination of communication circuits.
 7. Muffler: Blowout proof type between pumping plant and cylinder.
- P. Oil Cooling System: Provide an oil cooling system utilizing heat pipe technology similar to HyTec Oil Coolers as manufactured by Noren Products, Inc. of Menlo Park, California or equal.
- Q. Hydraulic Elevator Protective Circuit: In the event the car should stall due to low oil in the system or, if for other cause the car fails to reach the top landing within a predetermined time while traveling "up", a special circuit shall be provided which shall automatically return the car to the bottom landing and open the doors for 10 seconds after which the elevator will close doors and completely shut down. Recycling the mainline switch shall restore Service.
- R. Hydraulic Elevator Battery Emergency Lowering Operation: Provide a battery driven unit which will initiate operation of the Protective Circuit and lower elevator to bottom landing in the event of a power failure. Service shall be restored automatically upon restoration of normal power supply. Arrange with an exposed method of testing. Arrange circuitry so that, if the mainline switch is open when the power transfer takes place, the elevator will not respond to the operation of the protective circuit. Provide a double pole-isolating switch on the battery unit to disconnect the battery output.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Bidding Documents: Bidders shall examine architectural, structural, electrical and mechanical plans and specifications. Any discrepancies which affect the elevator work or conditions adverse to the bidder's equipment shall be brought to Owner's Representative's attention at least seven (7) days prior to the bid date. If no discrepancies are presented, changes required to accommodate bidders equipment become the responsibility and cost of the Elevator Contractor.

3.02 PREPARATION:

- A. Field Measurements: Field-verify dimensions before proceeding with the work. Coordinate related work by other trades. Verify the following to be acceptable for installation of elevators.
 - 1. Hoistway has been correctly sized and otherwise properly prepared.
 - 2. Equipment supports are satisfactory.
 - 3. Electrical rough-ins are correct.
 - 4. Do not begin installation until unsatisfactory conditions have been corrected.

3.03 INSTALLATION:

- A. General: Install per manufacturer's requirements, those of regulatory agencies and as specified.
- B. Welded Construction: Provide welded connections for installation of elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustments, inspection, maintenance and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.
- C. Sound Isolation: Mount rotating and vibrating elevator equipment and components on vibration-absorption mounts, designed to effectively prevent transmission of vibrations to structure and thereby, eliminate sources of structure-borne noise from elevator system.
- D. Lubricate operating parts of systems, including ropes, as recommended by manufacturer.
- E. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails, for accurate alignment of entrances with cars. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe workable dimensions at each landing.
- F. Erect guide rails plumb and parallel with maximum deviation of 1/16 inch. Anchorage of guide rails shall not compromise waterproofing. Do not bottom rails on pit floor.
- G. Grout sills with non-staining, non-shrink grout. Set units accurately aligned with finished floor at landings.
- H. Graphics: Provide graphics visible to public as selected by Owner's Representative.
- I. Manufacturer's Nameplates: Manufacturer's nameplates, trademarks or logos not permitted on surfaces visible to public.

3.04 TEMPORARY ELEVATOR USE DURING CONSTRUCTION:

- A. General: Should the General Contractor require the use of any elevator during construction, Contractor shall make arrangements directly with the Elevator Contractor, coordinate temporary facilities and pay all costs associated with the protection, operation and use of elevators.
- B. Maintenance: Elevators shall be maintained on a regular basis during the temporary construction use. A minimum of two hours per week per elevator shall be spent on examination, lubrication, adjusting and cleaning the elevator equipment.
- C. Damage: The Owner is entitled to receive new elevator equipment upon final acceptance of

the entire project. The Owner's representative will thoroughly examine all elevator equipment upon completion of temporary use and provide a punch-list outlining items that must be repaired or replaced to ensure the equipment is in new condition. Final acceptance and payment will not be made until all items have been satisfactorily completed.

- D. Schedule: Sufficient time must be allowed to prepare and adjust temporary elevators so that the entire elevator installation is ready for final acceptance.

3.05 TEMPORARY ACCEPTANCE AND USE BY OWNER:

- A. When an elevator is near completion and declared ready for service, before completion of other elevators, Owner agrees to accept elevator and place it into automatic service.
- B. The elevator must be tested and inspected by regulatory agencies and a permit to operate issued.
- C. A walk-through examination will be performed in the presence of Owner's Representative, General Contractor and Elevator Contractor to determine present condition of elevator.
- D. The Owner agrees to sign or cause the General Contractor to sign a temporary acceptance form that is mutually agreeable to all parties.
- E. During this temporary acceptance period, the Owner agrees to pay or cause the General Contractor to pay an agreed amount per day per elevator for regular maintenance. The cost for this maintenance per elevator, per day, shall be stated in the Elevator Contractor's bid.
- F. The guarantee and full maintenance period will be effective upon final acceptance of the entire installation.

3.06 FIELD QUALITY CONTROL:

- A. Regulatory Agencies Inspection: Upon completion of elevators, Contractor shall provide instruments, weights and personnel to conduct test required by regulatory agencies. The Contractor shall submit a complete report describing the results of the tests.
- B. Examination and Testing: When installation is ready for final acceptance, notify and assist Owner's Representative in making a walk-through review of entire installation to assure workmanship and equipment complies with contract documents. Provide equipment to perform the following tests:
 - 1. One-hour heat and run test with full load in car. Perform for one car of each duty.
 - a. Stop car at each floor in each direction.
 - b. Provide well-shielded thermometers for motor and verify that temperatures do not exceed 50 degrees Centigrade above ambient. Laser Temperature pointers acceptable
 - c. Performance and leveling tests shall be made before and after heat and run test.
 - 2. Check and verify operation of all safety features and special operations.
 - 3. Demonstrate and verify to the Owner's Representative the following:
 - a. Measure horizontal acceleration for a full speed, full rise up and down run.
 - b. Measure acoustical output levels in machine room, lobbies and cars for a full speed, full rise up and down run.
- C. Correction: Make corrections to defects or discrepancies at no cost to Owner. Should discrepancies be such that re-examination and retesting is required, the Elevator Contractor shall pay for all costs including those of Owner's representative fees.
- D. Final Acceptance: Final acceptance of the installation will be made only after all corrections are complete, final submittals and certificates received and the Owner is satisfied and the installation is complete in all respects. Final payment will not be made until the above is

completed.

- E. INSTRUCTIONS: Instruct Owner's personnel in proper use of each system during a minimum of one hour training session on the proper use of each system. This training session will be conducted onsite at the owner's convenience.

3.07 MAINTENANCE:

- A. General: Provide complete continuing maintenance on entire elevator equipment during regular working hours on regular working days for a period of 12 months after filing Notice of Completion.
- B. Examination: Include systematic examination, adjustment, and lubrication of elevator equipment whenever required and replacement of defective parts with parts of same manufacture as required for proper operation. Contractor not responsible for repairs to car enclosures, door panels, frames, sills or platform flooring resulting from normal usage or misuse, accidents and negligence for which Contractor is not responsible. Examinations shall be performed monthly expending a minimum of one and one-half hour per unit per visit performing preventative maintenance service.
- C. Performance Standards:
 - 1. Maintain the performance standard set forth in this Specification and maintain correct operation of the dispatching system.
 - 2. Maintain smooth starting and stopping, smooth riding qualities and accurate leveling at all times.
- D. Callbacks: In event of failures, provide 24-hour callback service at no additional cost to Owner.
- E. Elevator Shutdowns:
 - 1. Should any elevator become inoperative, repair within 24 hours of notification of such failure. Breakdown of major components shall be completed and service restored within 72 hours.
 - 2. Failure to comply with above, Owner may order the work done by other contractors at the Contractor's expense.
 - 3. Devices repaired or replaced by others shall, nevertheless, be provided with maintenance by the Contractor who shall become completely responsible for correct operation of such devices for lifetime of this contract.
- F. Follow-Up Tests: Test all safety devices and emergency operations at six (6) month intervals or oftener and submit written report on each test. Make tests at times which do not interfere with building operation.
- G. Maintenance Materials:
 - 1. Replacement Parts: Keep the following parts in a warehouse within 50 miles of the project premises.
 - a. One door operator motor of each type used.
 - b. Transformers of each type installed.
 - c. Two complete door interlocks.
 - d. Parts for motor drive units.
 - e. One encoder of each type installed.
 - f. Parts for door protective devices.
 - g. One set of packing for each size cylinder.

- h. Such other parts as are needed to insure prompt replacement in event of elevator shutdown such as spare control boards for computer-operated systems.
- H. Maintenance Data: After completion and prior to final acceptance, submit three sets of complete and accurate maintenance data specific for each elevator. Final payment will not be made until received.
 - 1. Maintenance Manuals: Describe proper use and maintenance of equipment, lubrication points, types of lubricants used and frequency of lubricant application, manufacturer's literature describing system maintenance and troubleshooting as specified.
 - 2. Owners Manuals: Describe operation of each feature, i.e. Independent Service, Security Operation, Guard Station Equipment, etc...that is specifically used by the owner or end user. Include details of what to do and what not to do with the elevator equipment In Case of Emergency, E.Q Fire, Evacuation etc....,
 - 3. Parts Catalogs: Complete listing of all parts of equipment and components used in the installation.
 - 4. Wiring Diagrams: One set mounted in machine room, one blue line set and one electronic version on CD delivered to Owner. Wiring diagrams shall be as built, specific for this installation, and reference identification on drawings shall match points identified on terminals of controllers.
 - 5. Maintenance Tool and Software Manuals: Provide maintenance tools and supporting software documentation required for the complete maintenance of the entire system including diagnostics and adjusting. Maintenance tool may be hand held or built into control system and shall be of the type not requiring recharging or reprogramming nor of the automatic destruct type. The tool and supporting software may be programmed to operate only with this project's identification serial numbering. If control system is of the type that the software is field up loadable, both a copy of the control software and the parameters shall be clearly marked and submitted to the owner on CD.
- I. Final Service and Inspection: Two weeks before expiration of the year's maintenance, the equipment shall be lubricated, fully serviced, adjusted to the standards designated and emergency service operation devices shall be checked. A representative of the Owner will make a complete inspection.
- J. Quotation: Base bid shall include cost of maintenance and materials as described above.

END OF SECTION

SECTION 22 05 53

PIPING PAINTING AND IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Paint exposed steel, piping and insulated piping and equipment in mechanical rooms and other similar unfinished spaces as called out in this Section.
- B. Identify piping and equipment.
- C. Install marking tape over exterior utilities.

1.2 SUBMITTALS

- A. Provide schedule of paint, colors and numbers if approved manufacturer other than one whose numbers are specified is used.
- B. Provide list of valves to be tagged and identifying description.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Paint: Benjamin Moore, Devoe, Pratt and Lambert, Rust-O-Leum.
- B. Pipe labels: Seton or Brady.
- C. Exterior utilities marking: Allen Systems, Inc., Brady or Seton.

2.2 PAINTING

- A. This Contractor shall be responsible for preparing and painting items described in this section with the exception of priming canvas insulation jacketing, which will be done under the insulation sections of this specification.

2.3 PIPE IDENTIFICATION

- A. Use one of the following systems:
 - 1. Equal to Brady pressure sensitive pipe markers, arrows and pipe banding tape, No. B-946 for insulated pipe and No. B-689 for uninsulated pipe, color coded as noted.

2.4 CEILING IDENTIFICATION MARKERS

- A. Equal to "Moore" 5/8 inch diameter marking tacks with celluloid covering suitable for ink notation on a colored face.

2.5 VALVE IDENTIFICATION

- A. Tags shall be brass (approximately 19 gauge), 2 inch round minimum, secured with brass "S" hook, chain, or plastic tie wrap.

2.6 EXTERIOR UTILITIES MARKING

- A. Install equal to Allen Systems, Inc. "Markline" marking tape over exterior underground metallic piping, cabling or wiring. Install equal to Allen Systems, Inc. "Detectatape" over exterior underground non-metallic piping.

PART 3 - EXECUTION

3.1 PAINTING

- A. Clean oil, rust and/or scale from exposed iron and steel work and paint with Extend-O-Rust neutralizer prior to finish coat of paint.
- B. Omit painting of galvanized or non-ferrous surfaces and factory-painted surfaces.
- C. Touch up factory finishes on exposed items of equipment in finished and unfinished spaces which become chipped or scratched during shipment, installation or during the construction period. Finish color to match factory color.
- D. Provide "Wet Paint" signs as required to protect newly painted finishes. Provide temporary protective wrappings as required to avoid paint spattering on surfaces near work area. Remove those coverings when painting is completed. Upon completion of painting work, clean window glass and other paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

3.2 PIPE IDENTIFICATION

- A. Label piping after painting is completed.
- B. At each side of label, tape with directional arrows shall be wrapped entirely around pipe with at least 1 inch overlap or across visible face of duct when standing on floor below.
- C. Identification shall occur at the following locations:
 - 1. At no more than 15 foot intervals on a straight run of pipe.
 - 2. Wherever a pipe or duct turns 90 degrees or tees.
 - 3. Wherever a pipe passes through a wall, floor, or ceiling, on both sides.
 - 4. At each branch or riser takeoff.
 - 5. Adjacent to one side of each valve, device, or fitting.
 - 6. At other locations, for ease of location and maintenance as directed by the Owner or Architect/Engineer.
- D. Furnish and install the following labels on the appropriate systems. The pipe service description and color schemes noted are intended to be standard manufacturer's labels. In

some cases, multiple standard labels or standard and custom labels will be required to be combined to achieve the desired description.

Pipe Service Description	Background	Letters
Domestic Cold Water	Green	White
Domestic Hot Water	Yellow	Black
Circulating Domestic Hot Water	Yellow	Black
Non-Potable Cold Water – Do Not Drink	Yellow	Black
Drain Water	Green	White
Sanitary Sewer	Green	White
Storm Sewer	Green	White
Vent	Green	White
Acid Waste	Yellow	Black
Acid Vent	Yellow	Black

- E. The following are custom labels which require longer lead times to receive. The Contractor shall order such labels in a timely manner so as to avoid delaying the project completion.

Pipe Service Description	Background	Letters
Nitrous Oxide	Blue	White
Nitrogen	Blue	White
Carbon Dioxide	Black	White
Oxygen	Green	White
Medical Air	Yellow	White
Patient Medical Vacuum	Green	White

- F. Identify all exposed piping and also piping in accessible concealed spaces, such as above lay-in type ceilings, below raised floors and at access panels in non-accessible ceilings and in walls.

3.3 CEILING IDENTIFICATION MARKERS

- A. Provide markers on all removable ceilings and ceiling access panels to indicate locations of valves, dampers, smoke detectors, etc. and other mechanical items that may require servicing or adjustment. Glue marking tacks in place with white glue to prevent their falling out.
- B. Color code markers as follows:
- Red: Fire dampers, smoke dampers, combination fire and smoke dampers, sprinkler shutoff valves, duct type smoke detectors.
 - Notation: D - Damper
V - Valve
S - Smoke Detector
H - Heat Detector
 - Yellow: Steam, reheat, and chilled water.
 - Notation: V - Valve
 - Gold: Automatic and balancing dampers.
 - Notation: V - Valve
D - Damper
 - Blue: Gases (Valves)
 - Notation: O - Oxygen

NO - Nitrous Oxide
N - Nitrogen
C - Carbon Dioxide
V - Vacuum
A - Medical Air
L - Lab Air

3.4 EQUIPMENT IDENTIFICATION

- A. After painting equipment as described above, identify air handling units, separate or remote HVAC coils, fans, pumps and other equipment by stenciling identification on each item; i.e., "AHU No. 1". Coordinate identification with Owner.

3.5 VALVE TAGS

- A. Provide valve tags on all valves, particularly in concealed spaces above ceilings and in pipe chases. Two (2) copies of a typewritten list identifying all numbered valves shall be mounted in plastic containers and submitted to the Owner through the Engineer. Valve tags shall be stamped with identifying description of the valve with lettering as approved by the Owner and Engineer.

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide new domestic water service from 5'-0" outside the building as shown on drawings, complete with shutoff valves, all in accordance with requirements of the municipality.
- B. Provide plumbing piping to serve all fixtures and equipment, as shown on drawings.
- C. Domestic water piping.

1.2 QUALITY ASSURANCE

- A. Plumbers shall be fully qualified and licensed by State authorities.
- B. The manufacturer's mark or name shall be attached to each length of pipe, fitting or device employed in the piping system.
- C. Products made of, or containing lead, asbestos, mercury, or other known toxic or hazardous materials are not acceptable for installation under this Section. Any such products installed as part of the work of this Section shall be removed and replaced with all costs for removal and replacement shall be borne solely by the Contractor(s).

1.3 REFERENCE STANDARDS

- A. ANSI (American National Standards Institute)
- B. ASTM (American Society for Testing and Materials)
- C. ASTM B813, Water-flushable lead-free flux
- D. ASTM B32, Lead-free alloy solder
- E. ASTM B828, Procedures for soldered joints

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. Exterior Utilities:
 - 1. Water Services - 2-1/2 Inch and Smaller: (No fittings below slab)
 - a. Type "K" soft copper, ASTM B88, with brazed joints.
 - 2. Water Service - 3 Inch and Larger:
 - a. Ductile iron pipe, ANSI A21.51, Grade 60-42-10, with thickness classifications as noted below:

8 Ft. Cover		12 Ft. Cover		16 Ft. Cover	
Size	Class	Size	Class	Size	Class
3"-12"	2	3"-12"	2	3"-12"	2

3. Cast iron or ductile iron fittings, ANSI A21.20; Class 250 for 12 inch and smaller; Class 150 for 14 inch and larger. Mechanical joints, ANSI A21.11. Pipe and fittings tar coated outside and cement lined inside, ANSI A21.4.

2.2 PIPING WITHIN BUILDING

A. Domestic Water Piping:

1. ~~Below Grade - 2-1/2 Inch and Smaller:~~
 - a. ~~Type 'K' soft copper tubing, ASTM B88, with brazed joints.~~
2. Below Grade - 3 Inch and Larger:
 - a. ~~Ductile iron pipe, ANSI A21.51, Grade 60-42-10; Class 2 for 12 inch and smaller; Class 1 for 14 inch - 24 inch. Maximum bury of 8'-0". Cast iron or ductile iron fittings, ANSI A21.10; Class 250 for 12 inch and smaller; Class 150 for 14 inch and larger. Mechanical joints, ANSI A21.11. Pipe and fittings tar coated outside and cement lined inside, ANSI A21.4.~~
 - b.a. Apply bituminous coating as described in Part 3. Match material specified by Civil Engineer for Site Water Distribution.
3. Above Grade - 2 Inch and Smaller:
 - a. Type "L" hard temper copper tubing with wrought copper fittings, assembled with 95/5 (antimony), 94/6 or 96/4 (silver), or 97/3 (copper).
4. Above Grade – 2-1/2 Inch to 10 Inch:
 - a. Grooved Copper Piping System, 150 PSIG and Less:
 - 1) Copper tubing system from 2-1/2" through 8" shall be installed using mechanical piping couplings of a bolted type, with a central cavity design pressure-responsive gasket along with grooved end copper or bronze fittings as available, as manufactured by Victaulic Company of America.
 - 2) Copper tube, ASTM B-88 (Type K, L, M, or DWV) - Roll grooved only in accordance to Victaulic current listed standards.
 - 3) Mechanical Couplings - Shall be Style 606 rigid couplings for copper consisting of a ductile iron cast housing coated with copper colored alkyd enamel, a synthetic rubber gasket of a central cavity pressure-responsive FlushSeal® design, with plated nuts and bolts to secure unit together.
 - 4) Mechanical Fittings – Shall be wrought copper, conforming to ASTM B-75 or B-152, or bronze sand castings, conforming to ASTM B-584-87. Fittings shall be manufactured to copper tubing sizes, with grooved ends designed to accept grooved mechanical couplings of the same manufacturer. (Flaring of tube and fitting ends to IPS dimensions is not allowed.)

PART 3 - EXECUTION

3.1 SEISMIC RESTRAINT

- A. Fabricate and support piping in accordance with specifications herein, and latest edition of CPC. Provide seismic restraint in accordance with a current OSHPD pre-approved system that carries a current OSHPD OPA Number. For seismic restraint, see Section 23 05 48.
- B. Install seismic separation assemblies at building seismic joints.

3.2 SIZE OF FIXTURE SUPPLIES, WASTE AND VENTS

- A. Size of fixture supplies, wastes and vents shall be as noted in plumbing schedule on drawings.

3.3 PREPARATION OF PIPING

- A. Ream pipe ends to remove burrs. Make joints smooth and unobstructed inside. Remove any obstructions or debris inside piping, blowing it out with compressed air or otherwise cleaning it internally immediately prior to assembly.
- B. Cap or cover open piping during erection to prevent entry of foreign objects.

3.4 GENERAL

- A. All excavation and backfilling shall be performed in accordance with Section 31 20 00.
- B. No lead bearing solders shall be used for assembly of piping specified under this Section. Flux shall be water-flushable and lead-free.
- C. Install horizontal piping parallel with adjacent walls and partitions unless otherwise shown. All risers shall be plumb. Springing or forcing piping into place will not be permitted unless specifically called for.
- D. Nipples shall be the same material, composition and weight classifications as the pipe with which they are installed. Close or running thread nipples shall not be used.
- E. Take branches and riser arms off the top of mains at a 45 degree angle, unless otherwise shown.
- F. Use a minimum of two field fabricated or installed fittings or joints when connecting piping to equipment or prefabricated piping assemblies.
- G. Pitch horizontal drainage and vent piping 1/4 inch per foot minimum for sizes smaller than 3 inch and 1/8 inch for sizes 3 inch and larger, unless indicated otherwise.
- H. Provide manual drain valves at low points, end of each main, and bottom of each riser, of domestic water piping. Drains to be 2 inch ball valves for piping 4 inch and larger and 3/4 inch for smaller piping. Drain valves shall be ball valves with hose adapters and caps.
- I. Run piping to pumps lines size as close as possible to pump connections. Pump shut-off valves, check valves and strainers shall be line size. Provide eccentric reducer, flat on top, at pump suction to reduce from line size to pump suction connection size, except where suction diffusers are used. Provide concentric increaser at pump discharge to increase from pump discharge connection to line size. Long radius reducing elbows may be substituted for reducers and increasers if radius of turn is in the vertical plane.

- J. Pump seal cavities or pump base plates shall be piped to drain, except when drawings or specifications indicate no drain piping, as for small in-line mounted or floor mounted pumps which have mechanical seals.
- K. Piping in finished portions of the building, except in mechanical equipment rooms where otherwise indicated on the drawings, shall be concealed.
- L. Provide clearance for installation of insulation and for access to valves, drains and unions.
- M. Install same type of underground piping material specified for inside building to 5 feet outside of building.
- N. Do not install piping within 3 feet in horizontal direction from electrical panels or equipment. Coordinate with Division 26 contractor.
- O. Rigidly secure drop elbow ears to structure.
- P. Test piping systems after erection and before concealing or covering. Arrange and pay for all tests of mechanical systems as required by code and as herein specified. Replace any materials or workmanship found faulty and retest the system.
- Q. Repair any damage resulting from leakage of piping during testing or guarantee periods without any expense to Owner.
- R. Perform tests in the presence of the proper inspectors or an authorized representative of Architect/Engineer.
- S. With remodeling projects, where it is not possible to isolate new piping for testing, take special care in the installation and in the inspection for leaks after connecting into an existing system. Where it is possible to isolate new piping, perform tests as required by governing codes or requirements hereinafter specified.
- T. Furnish certificates to Architect/Engineer that tests have been satisfactorily completed.

3.5 INSPECTION OF PLUMBING PIPING

- A. All plumbing systems shall be inspected at completion of each phase while under tests required by the Administrative Authorities, prior to concealment.
- B. Below Grade: All piping installed below grade shall be inspected prior to burial by the Architect, the Owner's Representative or the Engineer. Contractor must notify Architect or Engineer no less than 24 working hours prior to the desired inspection time. Should the piping be buried prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no cost to the Owner.
- C. Above Grade: All piping installed above grade shall be made available for inspection upon completion and prior to finish of walls and ceiling. Contractor must notify Architect or Engineer no less than 24 working hours prior to the desired inspection time. Should the piping be hidden prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no cost to the Owner

3.6 TESTING OF PLUMBING SYSTEMS

- A. Provide final test with fixtures in place with 1 inch water column air pressure.

- B. Test domestic water piping, tanks, etc., with hydrostatic pressure of 125 psig for a period of 2 hours.

3.7 CLEANING OF PLUMBING SYSTEMS

- A. Upon completion of the installation of the domestic water system, disinfect the system in accordance with the requirements of the State Department of Health and the local municipality. The minimum requirements for cleaning the system are as follows:
- B. Any water piping system or parts thereof installed or repaired shall be filled with a solution containing 50 parts per million of available chlorine and allowed to stand for 24 hours before flushing. This shall be done prior to building occupancy.
- C. Deionized Water System (Local Lab Use): Clean piping by flushing with system deionized water.

3.8 GROOVED CONNECTIONS

- A. Couplings, fittings, valves and pipe shall be assembled in accordance with latest published instructions of the manufacturer and local codes.
- B. All grooved couplings, fittings and valves shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- C. Pipe shall be checked to be certain it is free of indentations, projections, grooves, weld seams or roll marks on the exterior of the pipe over the entire gasket seating area to assure a leak-tight seal. Pipe ends must be square cut and in accordance with manufacturer's standards.
- D. Gaskets shall be of the central cavity pressure responsive design. Gasket style and grade shall be checked to be certain gasket supplied is suited for the intended service.
- E. Thorough lubrication of the gasket exterior including the lips and/or pipe ends and housing exterior is essential to prevent pinching of the gasket. Lubricants shall be of type recommended by the gasket manufacturer for the intended use.
- F. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products.
- G. Factory trained representative shall periodically inspect the product installation. Contractor shall remove and replace any improperly installed products.

3.9 CORROSION PROTECTION FOR UNDERGROUND PIPING

- A. After testing of underground piping, apply one heavy coat of a coal tar bituminous material, equal to Bitumastic 50, to stainless steel, aluminum, cadmium plated or galvanized steel bolts, rods, banding and other items constructed of these materials.

3.10 EXPANSION OF PIPING

- A. Provide expansion loops where shown on drawings or required to prevent damage to piping and equipment due to thermal expansion in the piping system.

- B. Where loops are shown, the height and width dimensions shall be adhered to where possible. If adjustments are necessary because of interferences with other work, obtain Engineer's approval before proceeding with fabrication of the loop.
- C. Install loops with "cold spring" so that loop will have 1/2 of the calculated expansion during normal operation.
- D. Where space does not permit installation of expansion loops, provide expansion joints as described in Section 22 11 19, Domestic Water Piping Specialties.
- E. Anchor pipe in an approved manner at points shown on drawings, using U-bolt or iron bar clamps secured to the building construction.
- F. Install guides to maintain the position and alignment of piping.
- G. Install runouts from mains and/or risers with swing joints of sufficient length to absorb vertical expansion or contraction of risers and horizontal expansion or contraction of mains.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, equipment or fixtures.
- I. Install piping connected to equipment to provide flexibility for thermal stresses and for vibration. Adequately support and anchor pipe so that strain from weight and thermal movement of piping is not imposed on the equipment.
- J. Provide piping passing through seismic, expansion, and construction joints with minimum 6 inch deflection capabilities in all directions. Anchor piping on both sides of joint so that building movement will not cause structural stress on piping supports. Use multiple flexible pipe connectors or seismic separation assemblies to achieve deflection capabilities indicated.

3.11 SERVICE CONNECTIONS

- A. Provide connections to water services as noted on the drawings in accordance with local utility or municipality requirements.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Sanitary waste and vent piping

1.2 QUALITY ASSURANCE

- A. Plumbers shall be fully qualified and licensed by State authorities.
- B. The manufacturer's mark or name shall be attached to each length of pipe, fitting or device employed in the piping system.
- C. Cast iron pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Institute (CISPI) and manufactured trademark.
- D. Products made of, or containing lead, asbestos, mercury, or other known toxic or hazardous materials are not acceptable for installation under this Section. Any such products installed as part of the work of this Section shall be removed and replaced with all costs for removal and replacement shall be borne solely by the Contractor(s).

1.3 REFERENCE STANDARDS

- A. ANSI (American National Standards Institute)
- B. ASTM (American Society for Testing and Materials)
- C. ASTM B828, Procedures for soldered joints
- D. CISPI 301, Latest Issue, Cast Iron Piping
- E. ASTM C564, Hubless Coupling Gaskets
- F. ASTM A74 and 888, Latest Issue, Cast Iron Piping

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Cast Iron Soil Pipe and Fittings: AB & I, Tyler Pipe and Charlotte Pipe. Manufactured by a CISPI Member company. Pipe and fittings shall bear the collective trademark of the CISPI.
- ~~B. Grooved Piping Systems: Victaulic or approved equal.~~
- ~~C. B. No-Hub Fittings: Anaco, Clamp-All, Husky, Mission, Tyler, or approved equal.~~

2.2 PIPE AND FITTINGS

- A. No-hub Fittings:

1. Sanitary sewer – above grade: Equal to Husky SD4000 or Clamp-All Hi Torque 125 no-hub coupling with a shield constructed of 304 corrugated stainless steel with a minimum thickness of 0.016 inches. Coupling sizes 1-1/2 through 4 inches shall have four bands and sizes 5 through 10 inches shall have 6 bands. The worm gear drive clamps shall have a hexagon head to accept a 3/8 inch socketed torque wrench. Clamps shall be tightened to a minimum of 80 inch pounds. Gaskets shall be manufactured using neoprene rubber meeting the requirements of ASTM C-564. Sealing rings shall be molded into the gasket and positioned under each torquing band. Coupling shall meet the performance requirements of standard FM 1680 Class 1. Smooth shielded couplings shall have a 304 stainless steel shield with a minimum shield thickness of 24 gauge. Coupling sizes 1-1/2 through 4 inches shall have two bands and sizes 5 through 10 inches shall have four bands. The coupling shall be torqued to between 115 and 125 inch pounds.

~~B. Exterior Utilities:~~

~~1. Sanitary Sewer:~~

- ~~a. 12 inch and larger: Reinforced concrete pipe, ASTM C76, Class III or greater, depending on trench loading calculations, with rubber gasket joints, ASTM C361.~~

- ~~2. Cast iron or ductile iron fittings, ANSI A21.20; Class 250 for 12 inch and smaller; Class 150 for 14 inch and larger. Mechanical joints, ANSI A21.11. Pipe and fittings tar coated outside and cement lined inside, ANSI A21.4.~~

2.3 PIPING WITHIN BUILDING

A. Sanitary Waste Piping:

1. Below Grade:
 - a. Bell and spigot cast iron with neoprene compression joints.
2. Above Grade:
 - a. Hubless cast iron pipe with no-hub fittings.

B. Vent Piping:

1. Below Grade:
 - a. Bell and spigot cast iron with neoprene compression joints.
2. Above Grade:
 - a. Hubless cast iron pipe with no-hub fittings.

C. Condensate Drain and Drain Piping:

1. Type "L" or "M" hard drawn copper tubing and wrought copper fittings assembled with 95/5 (antimony), 94/6 (silver), 97/3 (copper) or Harris "Brigit" non-lead bearing solder.

PART 3 - EXECUTION

3.1 SEISMIC RESTRAINT

- A. Fabricate and support piping in accordance with specifications herein, and latest edition of CPC. Provide seismic restraint in accordance with a current OSHPD pre-approved system that carries a current OSHPD OPA Number. For seismic restraint, see Section 23 05 48.
- B. Install seismic separation assemblies at building seismic joints.

3.2 SIZE OF FIXTURE WASTE AND VENTS

- A. Size of fixture wastes and vents shall be as noted in plumbing schedule on drawings.

3.3 PREPARATION OF PIPING

- A. Ream pipe ends to remove burrs. Make joints smooth and unobstructed inside. Remove any obstructions or debris inside piping, blowing it out with compressed air or otherwise cleaning it internally immediately prior to assembly.
- B. Cap or cover open piping during erection to prevent entry of foreign objects.

3.4 GENERAL

- A. All excavation and backfilling shall be performed in accordance with Section 31 20 00.
- B. No lead bearing solders shall be used for assembly of piping specified under this Section. Flux shall be water-flushable and lead-free.
- C. Install horizontal piping parallel with adjacent walls and partitions unless otherwise shown. All risers shall be plumb. Springing or forcing piping into place will not be permitted unless specifically called for.
- D. Nipples shall be the same material, composition and weight classifications as the pipe with which they are installed. Close or running thread nipples shall not be used.
- E. Take branches and riser arms off the top of mains at a 45 degree angle, unless otherwise shown.
- F. Use a minimum of two field fabricated or installed fittings or joints when connecting piping to equipment or prefabricated piping assemblies.
- G. Pitch horizontal drainage and vent piping 1/4 inch per foot minimum for sizes smaller than 3 inch and 1/8 inch for sizes 3 inch and larger, unless indicated otherwise.
- H. Piping in finished portions of the building, except in mechanical equipment rooms where otherwise indicated on the drawings, shall be concealed.
- I. Install same type of underground piping material specified for inside building to 5 feet outside of building.
- J. Do not install piping within 3 feet in horizontal direction from electrical panels or equipment. Coordinate with Division 246 contractor.
- K. Rigidly secure drop elbow ears to structure.
- L. Test piping systems after erection and before concealing or covering. Arrange and pay for all tests of mechanical systems as required by code and as herein specified. Replace any materials or workmanship found faulty and retest the system.
- M. All vertical and horizontal offsets in sanitary waste and rainwater piping shall be restrained in a manner satisfactory to the engineer regardless of their location in the piping system or the height of the system. In addition, when any stack in a piping system exceeds five (5) floors or 65 feet in height (whichever is greater), all joints including cleanouts in any pipe associated with that piping system shall be restrained. As a minimum, each restrained joint shall have an individual two (2) two-bolt riser clamp on each side of each joint with washer welded to one half of each riser clamp for piping 10" and smaller and for all larger piping

provide a four (4) bolt riser clamp (two bolts on each arm of each riser clamp) on each side of each joint. In all cases, the riser clamps across a joint shall be connected by all thread rods on each side of the riser clamps. The rods shall be extended between the riser clamp arms outside of the bolts on each arm for 10" and smaller piping and between the bolts on each arm for 12" and larger piping with nuts and washers on both sides of the riser clamp arms. Submit the proposed restraint detail for each type of joint or fittings to the engineer for review.

- N. Repair any damage resulting from leakage of piping during testing or guarantee periods without any expense to Owner.
- O. Perform tests in the presence of the proper inspectors or an authorized representative of Architect/Engineer.
- P. With remodeling projects, where it is not possible to isolate new piping for testing, take special care in the installation and in the inspection for leaks after connecting into an existing system. Where it is possible to isolate new piping, perform tests as required by governing codes or requirements hereinafter specified.
- Q. Furnish certificates to Architect/Engineer that tests have been satisfactorily completed.

3.5 INSPECTION OF PLUMBING PIPING

- A. All plumbing systems shall be inspected at completion of each phase while under tests required by the Administrative Authorities, prior to concealment.
- B. Below Grade: All piping installed below grade shall be inspected prior to burial by the Architect, the Owner's Representative or the Engineer. Contractor must notify Architect or Engineer no less than 24 working hours prior to the desired inspection time. Should the piping be buried prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no cost to the Owner.
- C. Above Grade: All piping installed above grade shall be made available for inspection upon completion and prior to finish of walls and ceiling. Contractor must notify Architect or Engineer no less than 24 working hours prior to the desired inspection time. Should the piping be hidden prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no cost to the Owner.

3.6 TESTING OF PLUMBING SYSTEMS

- A. Test sanitary, and vent piping with air pressure of 5 psig for a period of 15 minutes.
- B. Provide final test with fixtures in place with 1 inch water column air pressure.

~~3.7 GROOVED CONNECTIONS~~

- ~~A. Couplings, fittings, valves and pipe shall be assembled in accordance with latest published instructions of the manufacturer and local codes.~~
- ~~B. All grooved couplings, fittings and valves shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.~~
- ~~C. Pipe shall be checked to be certain it is free of indentations, projections, grooves, weld seams or roll marks on the exterior of the pipe over the entire gasket seating area to assure a leak tight seal. Pipe ends must be square cut and in accordance with manufacturer's standards.~~

- ~~D. Gaskets shall be of the central cavity pressure responsive design. Gasket style and grade shall be checked to be certain gasket supplied is suited for the intended service.~~
- ~~E. Thorough lubrication of the gasket exterior including the lips and/or pipe ends and housing exterior is essential to prevent pinching of the gasket. Lubricants shall be of type recommended by the gasket manufacturer for the intended use.~~
- ~~F. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products.~~
- ~~G.C. Factory trained representative shall periodically inspect the product installation. Contractor shall remove and replace any improperly installed products.~~

3.83.7 CORROSION PROTECTION FOR UNDERGROUND PIPING

- A. After testing of underground piping, apply one heavy coat of a coal tar bituminous material, equal to Bitumastic 50, to stainless steel, aluminum, cadmium plated or galvanized steel bolts, rods, banding and other items constructed of these materials.

3.93.8 SERVICE CONNECTIONS

- A. Provide connections to sanitary services as noted on the drawings in accordance with local utility or municipality requirements.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Air gap fittings
- B. Area drains
- C. Cleanouts
- D. Condensate drains
- E. Floor drains
- F. Floor sinks
- G. Trap primer valves

1.2 REFERENCE STANDARDS

- A. ASSE (American Society of Sanitary Engineering).
- B. ASTM (American Society for Testing and Materials).
- C. PDI (Plumbing Drainage Institute).

1.3 SUBMITTALS

- A. Submit shop drawings on all equipment provided under this section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Air Gap Fittings: Josam, J.R. Smith, Wade, Zurn.
- B. Area Drains: Josam, J.R. Smith, Wade, Zurn.
- C. Cleanouts: Josam, J.R. Smith, Wade, Zurn.
- D. Downspout Nozzles: Josam, J.R. Smith, Wade, Zurn.
- E. Floor Drains: Josam, J.R. Smith, Wade, Zurn.
- F. Floor Sinks: Josam, J.R. Smith, Wade, Zurn.
- G. Trap Primer Valves: Josam, J.R. Smith, Wade, Zurn.

2.2 AIR GAP FITTINGS

- A. Equal to Josam Series 88900. Pipe sizes 1 inch to 4 inches. Cast iron with air ports, threaded inlet and outlet.

2.3 CLEANOUTS

- A. Floors or Outdoors: Equal to Josam Series 56000. Furnish with adjustable flange, internal gasketed cleanout plug, secured round nikaloy cover. Top of cleanouts to be flush with floor or grade.
- B. Walls: Equal to Josam Series 58890. Furnish with secured round stainless steel cover and bronze tapped plug. Provide rust inhibitor within brass plug thread to prevent plug seizure to piping.

2.4 FLOOR DRAINS

- A. Floor drains shall be as scheduled on drawings.
- B. Provide 4 inch funnel strainer where indicated on the drawings.
- C. On Grade:
 - 1. Mechanical Room Drains: Equal to Josam Series 38250A. Furnish with coated cast iron body, trap primer fitting, integral 4 inch deep seal P-trap and full size cleanout, spigot outlet, double drainage flange, nikaloy medium duty loose set grate.
 - 2. General Use: Equal to Josam Series 30000-AJ. Furnish with cast iron body, trap primer fitting, 4 inch deep seal P-trap, spigot outlet, double drainage flange, nikaloy adjustable secured strainer.
- D. Above grade:
 - 1. General Use: Equal to Josam Series 30000-A. Furnish with cast iron body, trap primer fitting, bottom outlet with deep seal P-trap, double drainage flange, flashing collar when waterproof membrane is used and 6 inch diameter maximum nikaloy adjustable secured strainer.

2.5 FLOOR SINKS

- A. Floor sinks to be as scheduled on the drawings.
- B. On or above grade:
 - 1. General Use: Equal to Josam Series 49300 for square top. Equal to Josam Series 49220A for round top. Furnished with cast iron body, trap primer fitting, bottom outlet with deep seal P-trap, acid resistant interior, double drainage flange, flashing collar when waterproof membrane is used, internal aluminum dome strainer, {6 inch deep by 8 inch square top, full Nikaloy loose grate.6 inch deep by 8-1/2 inch round top, and cast iron non-traffic acid-resisting anti-tilting SUPER-FLO Grate.

2.6 TRAP PRIMER VALVES

- A. Equal to Josam Series 88250. Bronze valve with integral vacuum breaker, threaded connections for installation in cold water service.

PART 3 - EXECUTION

3.1 AREA DRAINS, FLOOR DRAINS, FLOOR SINKS-AND-PATIO DRAINS

- A. Set drains so that strainer top is level with finished floor surface. Floor finishes and elevations are shown on Architectural drawings.
- B. Adjustable strainers shall be adjusted to accommodate finished floor material.

3.2 CLEANOUTS

- A. Provide cleanouts for soil, waste and drain pipes at base of stacks, at every change in direction, where indicated on the drawings and as required by governing codes.
- B. Adjust floor cleanouts so that top of cleanout is level with finished floor material.

3.3 CONDENSATE DRAINS

- A. Provide a deep seal "P" trap at condensate drain beneath each air conditioning unit cooling coil, and extend piping to nearest floor drain, service sink or as shown on drawings. "P" trap may be omitted at fan-coil unit drains.
- B. Traps for roof mounted equipment shall be constructed of rubber; drain piping shall be {Type "M" copper with soldered joints} and shall be extended to nearest roof drain.
- C. Effective water seal of "P" trap shall be minimum of two times negative static pressure in fan plenum for draw-through fan unit, but not less than 3 inch. Depth of trap shall be minimum of one-half the plenum maximum negative static pressure.
- D. ~~Provide condensate drain piping from evaporator coils in walk-in freezer and walk-in cooler. Furnish and install electric heat cable along condensate drain piping from evaporator in walk-in freezer before piping is insulated. Refer to [Section 15430, Plumbing Specialties] [Division 16] for additional information.~~

3.4 INVERT ELEVATIONS

- A. Verify all invert elevations and exact locations before commencing work.

END OF SECTION

SECTION 22 14 16
STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide plumbing piping to serve all fixtures and equipment, as shown on drawings.
- B. Storm sewer piping

1.2 QUALITY ASSURANCE

- A. Plumbers shall be fully qualified and licensed by State authorities.
- B. The manufacturer's mark or name shall be attached to each length of pipe, fitting or device employed in the piping system.
- C. Cast iron pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Institute (CISPI) and manufactured trademark.
- D. Products made of, or containing lead, asbestos, mercury, or other known toxic or hazardous materials are not acceptable for installation under this Section. Any such products installed as part of the work of this Section shall be removed and replaced with all costs for removal and replacement shall be borne solely by the Contractor(s).

1.3 REFERENCE STANDARDS

- A. ANSI (American National Standards Institute)
- B. ASTM (American Society for Testing and Materials)
- C. CISPI 301, Latest Issue, Cast Iron Piping
- D. ASTM C564, Hubless Coupling Gaskets
- E. ASTM A74 and 888, Latest Issue, Cast Iron Piping

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Cast Iron Soil Pipe and Fittings: AB & I, Tyler Pipe and Charlotte Pipe. Manufactured by a CISPI Member company. Pipe and fittings shall bear the collective trademark of the CISPI.
- B. Grooved Piping Systems: Victaulic or approved equal.
- C. No-Hub Fittings: Anaco, Clamp-All, Husky, Mission, Tyler, or approved equal.

2.2 PIPE AND FITTINGS

A. No-hub Fittings:

1. Storm sewer – above grade: Equal to Husky SD4000 or Clamp-All Hi Torque 125 no-hub coupling with a shield constructed of 304 corrugated stainless steel with a minimum thickness of 0.016 inches. Coupling sizes 1-1/2 through 4 inches shall have four bands and sizes 5 through 10 inches shall have 6 bands. The worm gear drive clamps shall have a hexagon head to accept a 3/8 inch socketed torque wrench. Clamps shall be tightened to a minimum of 80 inch pounds. Gaskets shall be manufactured using neoprene rubber meeting the requirements of ASTM C-564. Sealing rings shall be molded into the gasket and positioned under each torquing band. Coupling shall meet the performance requirements of standard FM 1680 Class 1. Smooth shielded couplings shall have a 304 stainless steel shield with a minimum shield thickness of 24 gauge. Coupling sizes 1-1/2 through 4 inches shall have two bands and sizes 5 through 10 inches shall have four bands. The coupling shall be torqued to between 115 and 125 inch pounds.

B. ~~Exterior Utilities:~~

1. ~~Storm Sewer:~~

- a. ~~Extra strength vitrified clay pipe, ASTM C200, assembled with flexible compression joints, ASTM C425.~~
 - b. ~~Bell and spigot cast iron pipe with neoprene gasketing system.~~
 - c. ~~12 inch and larger: Reinforced concrete pipe, ASTM C76, Class III or greater, depending on trench loading calculations, with rubber gasket joints, ASTM C361.~~
2. ~~Cast iron or ductile iron fittings, ANSI A21.20; Class 250 for 12 inch and smaller; Class 150 for 14 inch and larger. Mechanical joints, ANSI A21.11. Pipe and fittings tar coated outside and cement lined inside, ANSI A21.4.~~

2.3 PIPING WITHIN BUILDING

A. Rainwater Piping:

1. Below Grade:

- a. Bell and spigot cast iron with neoprene compression joints.
- b. ~~12 inch and Larger: Reinforced concrete pipe, ASTM C-76, Class III or greater, depending on trench loading calculations with rubber gasket joints, ASTM C-361.~~

2. Above Grade:

- a. Hubless cast iron pipe with no-hub fittings.

PART 3 - EXECUTION

3.1 SEISMIC RESTRAINT

- A. Fabricate and support piping in accordance with specifications herein, and latest edition of CPC. Provide seismic restraint in accordance with a current OSHPD pre-approved system that carries a current OSHPD OPA Number. For seismic restraint, see Section 23 05 48.

- B. Install seismic separation assemblies at building seismic joints.

3.2 PREPARATION OF PIPING

- A. Ream pipe ends to remove burrs. Make joints smooth and unobstructed inside. Remove any obstructions or debris inside piping, blowing it out with compressed air or otherwise cleaning it internally immediately prior to assembly.
- B. Cap or cover open piping during erection to prevent entry of foreign objects.

3.3 GENERAL

- A. All excavation and backfilling shall be performed in accordance with Section 31 20 00.
- B. No lead bearing solders shall be used for assembly of piping specified under this Section. Flux shall be water-flushable and lead-free.
- C. Install horizontal piping parallel with adjacent walls and partitions unless otherwise shown. All risers shall be plumb. Springing or forcing piping into place will not be permitted unless specifically called for.
- D. Nipples shall be the same material, composition and weight classifications as the pipe with which they are installed. Close or running thread nipples shall not be used.
- E. Take branches and riser arms off the top of mains at a 45 degree angle, unless otherwise shown.
- F. Use a minimum of two field fabricated or installed fittings or joints when connecting piping to equipment or prefabricated piping assemblies.
- G. Pitch horizontal drainage piping 1/8 inch per foot minimum for sizes 3 inch and larger, unless indicated otherwise.
- H. Piping in finished portions of the building, except in mechanical equipment rooms where otherwise indicated on the drawings, shall be concealed.
- I. Install same type of underground piping material specified for inside building to 5 feet outside of building.
- J. Do not install piping within 3 feet in horizontal direction from electrical panels or equipment. Coordinate with Division 16 contractor.
- K. Rigidly secure drop elbow ears to structure.
- L. Test piping systems after erection and before concealing or covering. Arrange and pay for all tests of mechanical systems as required by code and as herein specified. Replace any materials or workmanship found faulty and retest the system.
- M. All vertical and horizontal offsets in rainwater piping shall be restrained in a manner satisfactory to the engineer regardless of their location in the piping system or the height of the system. In addition, when any stack in a piping system exceeds five (5) floors or 65 feet in height (whichever is greater), all joints including cleanouts in any pipe associated with that piping system shall be restrained. As a minimum, each restrained joint shall have an

individual two (2) two-bolt riser clamp on each side of each joint with washer welded to one half of each riser clamp for piping 10" and smaller and for all larger piping provide a four (4) bolt riser clamp (two bolts on each arm of each riser clamp) on each side of each joint. In all cases, the riser clamps across a joint shall be connected by all thread rods on each side of the riser clamps. The rods shall be extended between the riser clamp arms outside of the bolts on each arm for 10" and smaller piping and between the bolts on each arm for 12" and larger piping with nuts and washers on both sides of the riser clamp arms. Submit the proposed restraint detail for each type of joint or fittings to the engineer for review.

- N. Repair any damage resulting from leakage of piping during testing or guarantee periods without any expense to Owner.
- O. Perform tests in the presence of the proper inspectors or an authorized representative of Architect/Engineer.
- P. Furnish certificates to Architect/Engineer that tests have been satisfactorily completed.

3.4 INSPECTION OF PLUMBING PIPING

- A. All plumbing systems shall be inspected at completion of each phase while under tests required by the Administrative Authorities, prior to concealment.
- B. Below Grade: All piping installed below grade shall be inspected prior to burial by the Architect, the Owner's Representative or the Engineer. Contractor must notify Architect or Engineer no less than 24 working hours prior to the desired inspection time. Should the piping be buried prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no cost to the Owner.
- C. Above Grade: All piping installed above grade shall be made available for inspection upon completion and prior to finish of walls and ceiling. Contractor must notify Architect or Engineer no less than 24 working hours prior to the desired inspection time. Should the piping be hidden prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no cost to the Owner.

3.5 TESTING OF PLUMBING SYSTEMS

- A. Test storm piping with air pressure of 5 psig for a period of 15 minutes.
- B. Provide final test with fixtures in place with 1 inch water column air pressure.

3.6 CORROSION PROTECTION FOR UNDERGROUND PIPING

- A. After testing of underground piping, apply one heavy coat of a coal tar bituminous material, equal to Bitumastic 50, to stainless steel, aluminum, cadmium plated or galvanized steel bolts, rods, banding and other items constructed of these materials.

3.7 SERVICE CONNECTIONS

- A. Provide connections to storm services as noted on the drawings in accordance with local utility or municipality requirements.

END OF SECTION

SECTION 22 35 13

INSTANTANEOUS DOMESTIC WATER HEATER EXCHANGERS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Domestic water heaters.

1.2 REFERENCE STANDARDS

- A. AIA (American Institute of Architects) Guidelines for Hospital and Health Care Facilities.
- B. ANSI (American National Standards Institute).
- C. ASME (The American Society of Mechanical Engineers).
- D. ASSE (American Society of Sanitary Engineers).
- E. NEMA (National Electrical Manufacturer's Association).
- F. PDI (Plumbing Drainage Institute).
- G. UL (Underwriter's Laboratories).

1.3 SUBMITTALS

- A. Submit shop drawings on all equipment provided under this Section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Steam Water Heater (~~Helical coil~~): ~~Ace Boiler Inc., Aerco, Cemline Inc.,~~ Aerco, or approved equal.
- B. ~~Domestic Hot Water Storage Tanks: Lochinvar, A.O. Smith, RBI, State.~~

2.2 STEAM WATER HEATER

- A. Provide a factory assembled skid mounted instantaneous Cemline Series SEH steam water heater of the size and capacity as scheduled on the drawings.
- B. General: Provide a double-wall, vented, U-tube heat exchanger with steam in the tubes and heated water in the shell and with either a pneumatic or electronic operated steam control valve. Provide a demand-anticipator, which will anticipate a change in demand and maintain its outlet temperature under normal load conditions to $\pm 4^{\circ}$ F. ~~If providing pneumatic control valves, also provide an air compressor, refrigerated dryer and tank (plus all necessary tubing) to operate the control valve.~~

- C. ~~Performance for water heaters: Equal to an Ace Boiler Inc. Model DW-SP2.0-D capable of heating 100 GPM of water from 60°F to 120°F when supplied with 3130 pounds per hour of saturated steam at 75 PSIG to the control valve. See equipment schedule on drawings.~~
- D. Certification: Provide a unit with an ASME stamp to certify that it meets the Pressure Vessel Code, Section VIII, Division 1 for no less than 150 PSIG working pressure in the shell at 400°F and at least a 150 PSIG working pressure at 400°F in the tubes.
- E. Shell: Provide all stainless steel construction so that the water in the shell contacts only non-ferrous materials. Other grades of material are acceptable as long as the water contacts only non-ferrous materials. Include no water baffles in the shell, which are attached to the tubes. Insulate the shell in a manner, which is consistent with Section 23 07 10 Mechanical Insulation.
- F. Tubes: Provide double wall atmospherically vented vertical copper U-tubes. Configure the tubes so that they shed any accumulated scaling during normal thermal expansion and contraction during variations in the primary fluid flow. Include a visible leak detection port that will make any leak in an inner or outer tube wall immediately apparent.
- G. Accessories: Factory-package unit shall include the following accessories:
 - 1. ~~Steam control valve: Provide each unit with a pneumatic or electronic steam flow control valve. The Division 15 plumbing contractor shall coordinate with the Division 16 electrical contractor to provide a dedicated power supply suitable for connection to the air compressor system.~~ With an electronically operated control valve provide a solid state temperature sensor wired to an electronic control module. The valve shall employ a safety device to close the valve in the event of high domestic discharge hot water temperature or power failure.
 - 2. Integral bronze circulating pump with shut-off valves to circulate water across the tubes.
 - 3. AGA/ASME rated, tested and labeled temperature and pressure relief valve.
 - 4. Control panel. Include the following control panel components:
 - a. Double-solenoid temperature limit system.
 - b. Power on/tripped status lights.
 - c. Remote-read, dial thermometer and compound pressure gauge.
- H. Provide a Float and Thermostatic Trap with unit. The F & T trap shall be furnished as indicated per Section 23 22 16 Steam and Steam Condensate Specialties.
- I. Warranty: Provide a 1-year warranty for entire unit from the date of start-up with an additional warranty of 10 years on the pressure vessel and integral demand anticipator.
- J. Electrical: Disconnect and power wire to unit by Division 26.

~~2.3 DOMESTIC HOT WATER STORAGE TANKS~~

- ~~A. Design and Fabrication: Equal to Lochinvar Lock-Temp tanks that will deliver at least 80% of the total tank storage capacity at the domestic hot water temperature setpoint $\pm 5^{\circ}\text{F}$. Provide tanks with glass-fiber insulation and a steel jacket that is coated with baked enamel. Provide tanks that are factory-lined with at least 5/8 of an inch of C-17 Pre-Krete cement.~~

- ~~B. Fittings: Provide each tank with magnesium anodes and at least an 11-inch by 15-inch manhole for access to tank interior. Provide tanks with copper-silicon tappings and copper-lined nozzles in the configuration and sizes shown on the Drawings. In each tank, include an inlet baffle system equal to the Lochinvar Lock-Temp system that reduces turbulence, keeps the cold water near the bottom of the tank and reduces hot and cold water mixing.~~
- ~~C. Dimensions: Provide at least two 600-gallon tanks that are 48-inches in diameter and 87-inches tall to top of tank from finished floor. Other tank dimensions are acceptable only if they do not increase general construction costs for access or clearance. Ceiling clearance within room will be no more than 9 feet from finished floor.~~
- ~~D.K. Warranty: Provide a 3-year tank replacement guarantee.~~

PART 3 - EXECUTION

3.1 DOMESTIC WATER HEATERS

- A. Provide properly sized ASME and AGA rated, tested, labeled temperature and pressure-relief valve with discharge piped to within 12 inches of floor floor sink.
- B. ~~High temperature water for the dishwasher will be provided by an electric booster heater furnished by others. This Contractor shall pipe 140° F. water to the booster heater and 180° F. water from the heater to the dishwasher. Install a pressure regulating valve and relief valve furnished with the booster heater as required per the manufacture of the booster heater.~~

END OF SECTION

SECTION 22 60 00

GAS AND VACUUM SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Medical oxygen gas ~~system~~ pipng
- B. Medical compressed air ~~system~~ pipng
- C. Medical vacuum ~~system~~ pipng
- D. Carbon Dioxide ~~system~~ pipng and manifold
- E. ~~Area medical alarm system~~ Nitrous Oxide (N2O) and Nitrogen (N2) pipng
- F. ~~Medical zone valve cabinets~~
- G. ~~F.~~ Flexible connectors
- H. ~~G.~~ Flexible expansion loops
- I. ~~H.~~ Pipe alignment guides

1.2 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Supply of bottled medical gases for placement by this section.

1.3 REFERENCE STADARDS

- A. NFPA 99 – Standard for Health Care Facilities.
- B. UL – Underwriters Laboratories.
- C. Guidelines for Construction and Equipment of Hospital and Medical Facilities
- D. ANSI B16.18 – Cast Copper Alloy Solder-Joint Pressure Fittings.
- E. ANSI B16.22 – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- F. ANSI B40.1 – Gauges, Pressure and Vacuum, Indicating Dial Type-Elastic Element.
- G. ASTM B88 – Seamless Copper Water Tube.
- H. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration field Service.
- I. ASTM B819 – Seamless Copper Tube for Medical Gas Systems.
- J. AWS A5.8 – Brazing Filler Metal.
- K. CGA G-4.1 – Medical Gas Outlets.

- L. CGA G-7 – Compressed Air for Human Respiration.
- M. CGA P-2.1 – Medical-Surgical Vacuum Systems in Health Care Facilities.
- N. CGA 1120 – Nitrogen Outlets.

1.4 SUBMITTALS

- A. Submit shop drawings on all equipment provided under this Section.
- B. Shop Drawings: Indicate general assembly of components, mounting and installation details, and general layout of control and alarm panels. Submit detailed medical wall assembly drawings.
- C. Product Data: Provide manufacturers literature and illustrations for all components indicating size, dimensions and configuration.
- ~~D. Samples: Submit 2 of each outlet and each valve.~~
- ~~E.D.~~ Independent Testing Agency Reports: Indicate systems are complete, zone valves installed, alarm systems functional, and pressure and cross connections tests performed. Document tests.
- ~~F.E.~~ Manufacturer's Installation Instruction: Indicate requirements for equipment and systems.

1.5 PROJECT RECORD DOCUMENTS

- A. Record actual locations of piping, valving, and outlets.

1.6 OPERATION AND MAINTENANCE DATA

- A. Operation Data: Include installation instructions, assembly views, lubrication instructions, and assembly views.
- B. Maintenance Data: Include maintenance and inspection data, replacement part numbers and availability, and service depot location and telephone.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with NFPA 99 – ~~2005~~ Latest Edition.
- B. The manufacturer's mark or name shall be attached to each length of pipe, fitting, fixture and/or device employed in the piping system.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years documented experience.
- B. Installer: Company specializing in performing the work of this Section with minimum 3 years documented experience.
- C. Testing Laboratory: Company specializing in performing the testing of this Section with minimum 3 years documented experience.

1.9 REGULATORY REQUIREMENTS

- A. Conform to applicable State and Local code for medical gas systems.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of systems.

1.10 SCHEDULING

- A. Schedule Work to ensure equipment is installed and systems tested and certified prior to substantial completion.

1.11 EXTRA MATERIALS

- A. Provide 2 of each size of valve and outlet.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Valves:
 - 1. Chemtron 2 inches and smaller, Series 77-03
2-1/2 inches through 4 inches, Series 77-01
 - 2. Ohio Medical 2 inches and smaller, 0207-6260 Series
2-1/2 inches through 4 inches, 0207-6070 Series
 - 3. Puritan 2 inches and smaller, 230900 Series
2-1/2 inches through 4 inches, 211250 Series
- B. Pressure Gauges:
 - 1. Chemtron, Model #77-90.
 - 2. Ohio Medical, Model #841-0000-300 Series.
- C. Carbon Dioxide Manifold:
 - 1. Chemtron, Model #2500.
 - 2. Ohio Medical, Series #0321-7400-900.
 - 3. Puritan, Series 106200.
- D. Flexible Connectors: Hyspan, Mason Industries, Metra-Flex or approved equal.
- E. Flexible Expansion Loops: Mason Industries, Metra-Flex or approved equal.
- F. Pipe Alignment Guides: Hyspan or approved equal.

2.2 PIPE AND FITTINGS

- A. Factory Preparation: Wash inside of copper pipe and copper fitting with hot solution of sodium carbonate or trisodium phosphate mixed on pound to 3 gallons of water; rinse with water, and blow dry with oil-free dry nitrogen or compressed air.

- B. Oxygen, Compressed Air, Carbon Dioxide, Nitrous Oxide, and Nitrogen Systems Piping - Aboveground:
 - 1. Copper Tube: ASTM B819, Type K, hard drawn, pre-cleaned piping with field cleaned sweat fittings. Cleaning of fittings per NFPA 99.
 - 2. Fittings: ANSI B16.18, cast bronze, or ANSI B16.22 wrought copper.
 - 3. Joints: AWS A5.8, BCuP silver brazed.
- C. Oxygen, Compressed Air, Carbon Dioxide, Nitrous Oxide, Nitrogen, and Vacuum Systems Piping – Below Ground Buried:
 - 1. Copper Tube: ASTM B280, Type K, hard drawn.
 - 2. Fittings: ANSI B16.18, cast bronze, or ANSI B16.22 wrought copper.
 - 3. Joints: AWS A5.8, BCuP silver brazed.
 - 4. Piping shall be pre-cleaned and plugged with field cleaned wrought copper sweat fittings and silver solder joints. Provide tubing in single continuous length polyethylene outer tube. Cleaning of fittings and uncleaned piping per NFPA 99.
- D. Vacuum System Piping - Aboveground:
 - 1. Copper Tube: ASTM B88, Type L, hard drawn.
 - 2. Fittings: ANSI B16.18, cast bronze, or ANSI B16.22 wrought copper.
 - 3. Joints: AWS A5.8, BCuP silver brazed.

2.3 VALVES

- A. Factory Preparation: Prepare valves the same as for oxygen service per NFPA 99. For oxygen service disassemble and wash in hot solution of sodium carbonate or trisodium phosphate mixed one pound to 3 gallons of water, rinse with water, seal, and pack for shipping.
- B. Ball Valves: FS WW-V-35, Type II, Class A brass or bronze body blowout proof stem, full port, double-seal ball valves for minimum 400 pounds per square inch working pressure, labeled for intended service. Valves up to 2- and 4-inch sizes shall have Teflon seats and adjustable stem packing gland with Teflon stem seal. For 2-1/2- through 3-inch sizes, valves shall have Teflon seats and double Teflon stem seal. Actuate from full "on" to full "off" by 90 degree turn of vinyl gripped valve handle. Factory installed copper tubing shall extend sufficiently to help prevent valve seat damage during soldering.
- C. Check Valves: Equal to Bivco in-line with screwed ends, Series 3000/4000, or Amico Alert-1 Series with inlet and outlet extensions manufactured, cleaned and sealed for medical use.

2.4 PIPING

- A. Hangers and Supports: See Section 23 05 10.
- B. Identification: Pressure sensitive adhesive tape and decals, color labeling to conform to Section 23 05 53.
- C. Vacuum Bottle Brackets: Stainless steel, chrome-plated metal, or aluminum with finish matching adjacent outlet.
- D. Flexible Connectors: Seamless or seam-welded tubing of stainless steel or bronze.

2.5 PRESSURE GAGES

- A. Oxygen and nitrous oxide systems: Manufactured and labeled expressly for intended service; UL labeled.
- B. ANSI B40.1, white dials and black lettering with restrictor.

2.6 CARBON DIOXIDE MANIFOLD

- A. Provide a fully automatic manifold control including shelf-shifting to reserve bank on exhaustion of service bank without decrease in delivery line pressure and automatic resetting of the control unit identifying the supply banks of cylinders. Preclude an inadvertent operating sequence in which the "reserve" cylinder bank is partially depleted. Replaced full cylinders shall always become the "reserve" in each cycling of the control.
- B. Incorporate the control unit pressure switches for the purpose of actuating designated remote signal systems when service bank is exhausted. In addition, the control unit shall provide non-electric, visible indication of control unit status for normal and reserve in use signals. Include high pressure gauges in the control unit for both banks of cylinders, and the delivery line pressure gauge. Locate gauges and indicators on the control unit, independent of the cover in a convenient instrument cluster panel.
- C. Provide a weather- and impact-resistant cover to protect internal components. Arrangement and installation as shown on drawings and/or schedule. Divide cylinder connections and header bars into two equal banks to the right and left of the control. Provide connections including the header bars, gas specific and non-interchangeable.
- D. Provide control 120-volt transformer as required.

2.7 PRESSURE SENSOR

- A. Line pressure sensing device that attaches to vacuum or medical gas lines. It continually passes pipelines status information to a display/alarm monitor. When pulse pressure sensors are connected, the integrated alarm system panel reports lines pressures, alarm conditions and other information important to hospital personnel.
- B. The pulse pressure sensor can monitor vacuum line status and line pressure for a full range of gases including air, oxygen, nitrogen, nitrous oxide, carbon dioxide and mixtures of these gases. Three (3) models of pulse pressure sensors are:
 - 1. Vacuum line model (0-30" Hg).
 - 2. Low pressure model (for lines with pressures up to 10 psi).
 - 3. High pressure model (for lines with pressures up to 225 psi).

2.8 FLEXIBLE CONNECTORS

- A. For steel piping application use flexible connectors with an inner hose of annular corrugated stainless steel, an exterior sleeve of braided stainless steel, a pressure rating of 150 pounds per square inch gauge, joints for 2 inch diameter and larger shall be flanged and for smaller than 2-inch diameter shall be threaded with unions. Size shall be same size as piping connected to.

- B. For copper piping application use flexible connectors with an inner hose of bronze, and exterior sleeve of braided bronze, a pressure rating of 150 pounds per square inch gauge, joints shall be threaded with unions or soldered as specified for pipe joints. Size shall be same size as piping connected to.

2.9 FLEXIBLE EXPANSION LOOPS

- A. Provide flexible piping connectors at the following locations or where indicated on drawings.
 - 1. Seismic joint.
 - 2. Building expansion joint.
 - 3. Building construction joint.
- B. Expansion joints shall be of the braided stainless steel type. Joints to consist of two flexible sections of hose and braid, two 30 elbows, and a 60 return. Flexible hose section to be stainless steel, close pitch, annular corrugated hose with a braided outer covering of stainless steel. End connections to match mating piping. The overall length shall allow for a minimum of ± 4 " movement in any direction.

2.10 PIPE ALIGNMENT GUIDES

- A. Guides to be pressed steel joined together by fusion welding with a protective black lacquer paint finish.

PART 3 - EXECUTION

3.1 SEISMIC RESTRAINT

- A. Fabricate and support piping in accordance with specifications herein, and latest edition of NFPA. Provide seismic restraint in accordance with a current OSHPD pre-approved system that carries a current OSHPD Number. For seismic restraint, see Section 23 05 48.
- B. Install seismic separation assemblies at building seismic joints.

3.2 GENERAL

- A. Install horizontal piping parallel with adjacent walls and partitions unless otherwise shown. All risers shall be plumb. Springing or forcing piping into place will not be permitted unless specifically called for.
- B. Piping for these systems shall be stored separate from piping for other systems to avoid mixing of piping types.
- C. All control wiring for medical alarm systems by Division 22.
- D. Power wiring to alarm panels by Division 26.

3.3 PREPARATION OF PIPING AND INSTALLATION

- A. Install, clean and test non-flammable medical gas piping systems, such as oxygen, nitrous oxide, carbon dioxide, nitrogen, medical compressed air and lab compressed air in accordance with NFPA 99.

- B. After erection of pipe and tubing, but prior to installation of service outlet valves, blow systems clear of free moisture and foreign matter with nitrogen gas.
- C. Install service outlet valves, subject system to test pressure of 150 psig with nitrogen or dry compressed air. Check with soapy water. Provide 24-hour standing pressure test.
- D. After cleaning, great care shall be exercised in storage and handling of all materials and in condition of tools used in cutting or reaming to prevent oil or grease being introduced into tubing. Where such contamination is known to have occurred, the materials affected must be rewashed and then rinsed.
- E. Ream pipe ends to remove burrs. Make joints smooth and unobstructed inside. Remove any obstructions or debris inside piping, blowing it out with compressed air or otherwise cleaning it internally immediately prior to assembly.
- F. Cap or cover open piping during erection to prevent entry of foreign objects.
- G. Pre-Installation Cleaning: Disassemble positive pressure gas systems pipe fittings, valves, and components, except those supplied cleaned and prepared for intended service, and thoroughly wash in hot solution of sodium carbonate or trisodium phosphate mixed one (1) lb. to three (3) gal. of water. Scrubbing and continuous agitation of the parts shall be employed where necessary to remove all deposits and insure complete cleaning. After washing, rinse all materials thoroughly in clean hot water.
- H. After cleaning, great care shall be exercised in storage and handling of all materials and in condition of tools used in cutting or reaming to prevent oil or grease being introduced into tubing. Where such contamination is known to have occurred, the materials affected must be rewashed and then rinsed.
- I. All brazing shall be performed under a continuous flow of nitrogen gas (nitrogen purge method); nitrogen gas purge method can be omitted on medical vacuum. No flux shall be used on these piping systems.
- J. Effect changes in size with reducing fittings. Make change in direction of required turns or offsets with fittings or tubing shaped by bending tools. Make bends free of flattening, buckling or thinning of tube wall.
- K. Cut pipe and tubing accurately and install without springing or forcing.
- L. Install exposed oxygen piping in wall mounted sheet steel raceways and junction boxes.
- M. Grade piping down in direction of flow.
- N. Provide pipe sleeves where pipes and tubing pass through walls, floors, roofs, and partitions. finish flush at both ends. Extend 2 inches above finished floors. Pack space between pipe or tubing and sleeve, and caulk.
- O. Support gas piping with pipe hooks or hangers suitable for size of pipe as specified in Section.
- P. Install isolation valves adjacent to main lines for risers if manual shut off valves (zone control valves) are more than 15 feet from main or riser.

1. Locate them immediately adjacent to main or riser.
 2. Ensure that they are not accessible to unauthorized personnel.
 3. Identify gas and function.
 4. Leave them in the open position with handle removed or sealed.
- Q. Except where indicated or in flush wall mounted cabinets, install manual shut off valves with stem vertical and accessible for operation and maintenance.
- R. Install strainers on inlet side of pressure reducing valves. Provide main gas valves (pressure reducing or flow control) with bypasses and isolation valves to permit maintenance without interruption of gas.
- S. Provide a valved bypass around receivers.
- T. Identify piping with tape and decals. Provide piping identification code and schematic. Refer to Section 23 05 53. Install labeling on pipe at intervals of not more than 10 feet and at least once in each room and each story traversed by pipeline.
- U. Excavate and backfill pipe trenches as specified. Coordinate provision of utility warning and identification tape with backfill operation. Provide backfill above buried lines at a depth of 8 to 12 inches below finish grade.
- V. Install underground piping in trench minimum 42 inches deep adequately protected against physical damage and corrosion, or in ducts and tunnels which are not occupied by fuel oil lines and are vented.

3.4 PIPING SYSTEMS CLEANING AND PRESSURE TESTING

- A. After erection of pipe and tubing but prior to installation of service outlet valves, blow systems clear of free moisture and foreign matter with nitrogen gas.
- B. Install service outlet valves, subject system to test pressure of 150 psig with nitrogen or dry compressed air. Check with soapy water. Provide 24-hour standing pressure test.
- C. Clean and test piping per NFPA 99 requirements.

3.5 GAS SYSTEM TESTING REQUIREMENTS

- A. The following is a summary of the requirements for medical gas testing as found in NFPA 99.
1. Cleaning: Blow out lines with dry nitrogen or air.
 2. Pressure Testing:
 - a. Visually inspect each brazed joint prior to covering piping system to assure that the alloy has flowed completely in and around the joint and, where flux has been used, that the hardened flux has not formed a temporary seal that holds test pressure. Remove all excess flux for clear visual inspection of brazed connections.
 - b. Prior to covering piping system with gauges and alarms disconnected and relief valves and outlets blocked off, leak test at 150 psig.
 - c. With all components connected, leak test at 20 percent above normal operating pressure for 24 hours.

3. Cross-Connection Test:
 - a. With all components connected, perform cross connection test at 50 psig.
 - b. Verify correct labeling of outlets, shut-off valves and alarm panels per.
 - 1) Test shut-off valves.
4. Purging: Using the proper system gas, purge the end of the piping system (Level 1 future tie-in valves) through a white cloth at a minimum flow rate of 225 liters per minute (recommend 200 to 300 liters per minute). Continue purging until no evidence of discoloration is apparent, and the gas used during the previous tests has been removed from the piping system.
 - a. An adequate supply of white cloths shall be on hand to purge and test all systems.
5. Analysis:
 - a. Test equipment shall be calibrated at regular intervals and calibration certificates shall be available at the test site for inspection.
 - b. Test each end of piping system for oxygen, medical air, and mixed gases containing oxygen to determine oxygen content (percent). (Recommend that hospital respiratory therapist establish acceptable levels of oxygen).
 - c. Verify that medical air meets the following:

<u>Item</u>	<u>Limiting Characteristic</u>
Oxygen	19.5 to 21.5 percent
Dew Point	10F below the minimum ambient temperature to which any part of the medical air piping system can be exposed.
Oil (condensed)	5 mg/cubic meter
Carbon Monoxide	10 ppm
Carbon Dioxide	1000 ppm
 - d. The gas analysis report shall indicate test method(s) and/or devices used.
6. Flow/Pressure Test:
 - a. Verify each medical gas end of system piping is at 50 to 55 pounds per square inch gauge at maximum flow rate.
7. Record Keeping:
 - a. Prior to the use of any medical gas piping system for patient care, the responsible authority of the facility shall assure that all tests required have been successfully conducted and permanent records of the test maintained in the facility files.
 - b. Per California Code of Regulations (CCR) Title 22, Division 5, Division 1 (e), the piped oxygen or nitrous oxide systems shall be tested in accordance with NFPA 99 in each of the following instances:
 - 1) Upon completion of initial installation.
 - 2) Whenever changes are made to the system.
 - 3) Whenever the integrity of the system has been breached.
 - 4) At least annually.

3.6 FLEXIBLE CONNECTORS

- A. Provide flexible pipe connectors on pipes connected to vibration isolated equipment and where shown. Do not allow weight of piping to be carried by equipment connector.

- B. Install devices in accordance with manufacturer's recommendations.

3.7 FLEXIBLE EXPANSION LOOPS

- A. Provide piping passing through seismic, expansion, and construction joints. Anchor piping on both sides of joint so that building movement will not cause structural stress on piping supports.
- B. Install devices in accordance with manufacturer's recommendations.

3.8 EXPANSION JOINTS AND COMPENSATORS

- A. Install devices in accordance with manufacturer's recommendations.

3.9 PIPE ALIGNMENT GUIDES

- A. Install guides as shown on drawings and where recommended by expansion joint manufacturer.
- B. Rigidly anchor pipe to building structure where necessary. Provide pipe guides so that movement takes place along axis of pipe only.

END OF SECTION

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC MECHANICAL

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. The work included under Division 22 and 23 shall consist of furnishing labor and materials necessary for the complete installation of plumbing, heating, ventilating, air conditioning, fire protection, temperature control and building automation systems shown on the Contract Drawings and specified in this Division. All work shall be complete and left in operating condition at termination of Contract.
- B. The Contractor shall include minor items which are obviously and reasonably necessary to complete the installation and usually included in similar work even though not specifically mentioned in the Contract Documents such as bolts, nuts, anchors, brackets, sleeves, piping drains and drips at low points and minor offsets in ductwork and piping because of unforeseen obstructions.
- C. Some equipment and materials provided under Divisions 22 and 23 or Division 26 may require composite work crews because of trade jurisdiction. Where this occurs, the Contractor or Subcontractor shall include in their price their portion of the composite crew labor costs. It is the Contractor's or Subcontractor's responsibility to review Divisions 23 and Division 26 Contract Documents to determine where these composite crews are required.
- D. The Contractor shall arrange with the appropriate utility companies to provide utility services as required and coordinate their installation with the construction progress of this project.
- E. Where material quantities are shown, they are for the convenience of the Contractor only. The Contractor shall be responsible to verify all quantities.
- F. Contractor shall be responsible for filling out any required paperwork to receive rebates from local Utility Companies for energy efficient equipment.

1.2 RELATED SECTIONS

- A. Bidding Requirements, Contract Forms, Conditions of the Contract and Divisions 1 and 2 apply to all work of Divisions 22 and 23 are an integral part of this specification. Where the conditions herein specified in this Division are at variance with other Divisions, this Division shall take precedence. Section 23 05 00 specifies conditions, procedures, equipment and material particular to the mechanical work and applies to all mechanical work of the Contract Documents.
- B. The Contract Forms, Bidding Documents, General Conditions of the Contract, Supplemental General Conditions and other applicable portions of Division 1 and all Addenda issued prior to Agreement executions form a part of and apply to all contracts or sub-contracts relating Division 22 and 23 work. This section applies to all other Division 22 and 23 sections or parts thereof that are copied for use by Subcontractors and suppliers and shall be included with those copies.
- C. Where a specification section refers to other sections under the Article entitled "Related Sections," this is done for Contractor's convenience only. It shall in no way exonerate the contractor of responsibilities spelled out in other sections of the specifications, even though not specifically referenced. The contractor is held responsible for all information contained in

this Division specifications as well as for information contained in the architectural and Division 246 specifications as they may affect their work.

1.3 PERMITS, LICENSES AND FEES

- A. All temporary and permanent permits and licenses required in connection with this Division's work shall be the responsibility of the contractor bidding the work. All fees and expenses required for such permits and licenses shall be paid for by the Contractor.
- B. Fees and costs charged by utility companies for utility services will be paid for by the Owner.
- C. When the Owner has elected to pre-purchase equipment as identified in other sections of this specification or elsewhere in the contract documents, the contractor shall be responsible for all permits, licenses, and fees associated with the installation of pre-purchased equipment. The contractor bidding the work shall obtain all permits and pay all fees and expenses required for the installation of pre-purchased equipment. The contractor shall contact ~~{the Owner} [name and telephone number of Owner's representative]}~~ to obtain the value and an itemized listing of the pre-purchased equipment.

1.4 STATE AND LOCAL SALES TAXES

- A. Contract figures shall include State and Local Sales Taxes. Keep accurate records of these taxes and furnish such records to the Owner upon demand.

1.5 REFERENCES

- A. The Contract base bid shall be based on the project Contract Documents (drawings and specifications). The installation shall meet or exceed current applicable codes, ordinances and regulations in effect at the building site. If a Contractor or Subcontractor observes that the contract documents are at variance with governing codes and regulations, he shall promptly notify the engineer in writing, who will respond to such variances in writing. If the contractor performs work knowing that it is not in compliance with applicable codes, and does not notify the Engineer, the Contractor shall assume full responsibility and bear all costs attributable to correcting the non-complying work.
- B. Codes and standards are considered minimum acceptable construction but the reference to Codes and Standards shall not permit a lower grade of construction where drawings and specifications call for workmanship and materials in excess of those references.
- C. The latest and most up to date version shall be considered as the minimum requirements. A partial list of governing codes follows:
 - Americans with Disabilities Act
 - California State and Local Building Codes and Ordinances
 - California Plumbing Codes
 - California Fire Codes and Regulations
 - California Mechanical Code
 - California Electrical Code
 - California State and Local Electrical Installation Codes
 - Municipal Water and Sewer Regulations
 - Occupational Safety and Health Administration Regulations
 - Underwriter's Laboratories

Owner's Insurance Carrier

- D. The following is a list of organizations and their abbreviations where referred to in the specifications as standards of construction.

ADA - Americans with Disabilities Act

ADC - Air Diffusion Council

ARI - Air Conditioning and Refrigeration Institute

AMCA - Air Moving and Conditioning Association, Inc.

ACI - American Concrete Institute

ACGHI - American Conference of Governmental Industrial Hygienists

AGA - American Gas Association

AISC - American Institute of Steel Construction

ANSI - American National Standards Institute

ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers

ASME - American Society Mechanical Engineers

ASPE - American Society of Plumbing Engineers

ASTM - American Society for Testing and Materials

AWWA - American Water Works Association

AWS - American Welding Association

AABC - Associated Air Balance Council

CSA - Canadian Standards Association

ETL - Electrical Testing Laboratories

FM - Factory Mutual

IRI - Industrial Risk Insurance

IEEE - Institute of Electrical and Electronic Engineers

NBFU - National Board of Fire Underwriters

NEMA - National Electrical Manufacturers Association

NEBB - National Environmental Balancing Bureau

NIST - National Institute of Standards and Technology (Formerly NBS)

NFPA - National Fire Protection Association

National Safety Code for Mechanical Refrigeration

OSHA - Occupational Safety and Health Administration

PDI - Plumbing and Draining Institute

SMACNA - Sheet Metal and Air conditioning Contractors National Association

UL - Underwriters' Laboratories, Inc.

1.6 DEFINITIONS

- A. Where the terms "provide" or "shall be" are used in this specification or on the drawings, they shall be taken to mean "The Mechanical Contractor or any of their Subcontractor(s) shall furnish and install."
- B. The drawings and specifications are intended to supplement each other. Any items shown on the drawings and not mentioned in the specifications, or vice versa, shall be executed the same as if mentioned and shown. The greatest quantity or more expensive work shall govern when there is a conflict in or between the drawings and/or specifications.
- C. The drawings attempt to give reasonable indications of the locations of equipment, accessories, pipe, duct, etc. Each location shall be determined by reference to the general building plans and by actual measurement at the project site. Any reasonable changes in the locations indicated, up to a measurement of 3'-0", shall be made by the Contractor without incurring additional cost to the Owner, if such changes are ordered prior to the performance of the affected work.
- D. In some cases, the Owner may desire to identify costs associated with certain pieces of equipment as provided by different manufacturers to help in evaluating which equipment to buy. Where this occurs, the specifications will indicate a Base Bid manufacturer and Alternate Bid manufacturers. The contractor, as a part of their bid, shall include the Base Bid equipment manufacturer even if he desires to use an Alternate Bid manufacturer. If there is a desire to use an Alternate Bid manufacturer, the contractor shall identify the cost of this manufacturer as an alternate price on the Bid Form. If the Bid Form does not include a line item for this Alternate Bid, the contractor shall immediately bring this to the engineer's attention, who will provide instructions on how to include the Alternate Bid. If no Alternate Bid is proposed by the Contractor, the Base Bid equipment shall be provided on the project.
- E. The listing of a manufacturer's name in the Contract Documents (specifications and/or drawings) means a manufacturer may submit a product if it complies in all respects with each of the requirements of the Contract Documents. For substitutions of materials and equipment, refer to Article 1.11, entitled "Submittals," included hereinafter.
- F. The term "Approved Equal" refers to an acceptable alternative manufacturer which is different from those listed in the specification and which has been submitted to the Engineer for review prior to the submission of a bid. The term "Approved Equal", in and of itself, is not an acceptable manufacturer name. The Engineer at their sole discretion shall determine what is equal to the specified product. The data submitted shall comply with Article entitled "Submittals", included hereinafter.

1.7 SITE VISITATION

- A. Inspection of Site: Before submitting a proposal on the work contemplated, the Contractor and Subcontractors shall examine the site of the proposed work and thoroughly familiarize himself with all existing conditions and limitations affecting the performance of their work. No extra compensation will be allowed because of a misunderstanding as to the amount of work involved or lack of knowledge of any existing conditions that could have been discovered or reasonably anticipated prior to bidding.

1.8 EXPLANATION AND PRECEDENCE OF DRAWINGS

- A. For purposes of clearness and legibility, drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale wherever possible, Contractor shall make use of data in the contract documents and shall verify this information at the building site.

- B. The drawings indicate required size and points of termination of pipes; indicate conduits and ducts; suggest proper routes to conform to structure; avoid obstructions; and preserve clearances. However, it is not intended that drawings indicate all necessary offsets. It shall be the responsibility of and the work of the Contractor to make the installation in such a manner as to conform to structure, avoid obstructions, preserve headroom, and keep openings and passageways clear without further instructions from or cost to the Owner.
- C. Furnish shop drawings indicating changes to meet space requirements, code requirements, and, as necessary, to resolve space conflicts.
- D. It is intended that apparatus be located symmetrical with architectural elements. Refer to architectural details in completing and correlating work.
- E. The Contractor shall fully inform himself regarding peculiarities and limitations of the spaces available for the installation of work and materials furnished and installed under the contract. The Contractor shall exercise due and particular caution to determine that all parts of their work are made quickly and easily accessible.
- F. Submittal of bid shall indicate the Contractor has examined the site and bid documents, and has included required allowances in their bid. No allowance shall be made for any error resulting from Contractor's failure to visit job site and to review bid documents.
- G. Before submitting a bid, carefully study drawings, and determine in advance, the methods of installing and connecting the apparatus, the means to be provided for getting the equipment into place, and thoroughly familiarize yourself with all the requirements of the contract. After award of the contract, no subsequent allowances will be made due to failure to comply with the above requirements and other conditions affecting the installation and completion of all work.

1.9 MATERIALS

- A. Provide new materials, in good condition and of domestic manufacture unless otherwise specified herein. Provide materials for similar uses of same type and manufacturer.
- B. Provide equipment with manufacturer's label showing performance characteristics. Use identifying size number only when it is not practicable or customary to show performance characteristics.
- C. Provide valves, pipe, fittings, and other pipe appurtenances, which bear the manufacturer's name or trademark.
- D. Unless otherwise specified herein, install equipment and fixtures in accordance with the manufacturer's recommendations, including recommended service and removal clearances.

1.10 SUBMITTALS

- A. List of materials and subcontractors.
 - 1. Submit three (3) copies of a complete list of all materials, equipment, and Subcontractors proposed to be used on this project to the engineer within fourteen (14) calendar days of the award of contract or written authorization to proceed. If such list is not submitted by that time, it will be assumed that all equipment and materials will be exactly as specified and any exceptions are at the discretion of the Engineer.
 - 2. Only Subcontractors named on an Engineer approved list will be allowed to work on the project.

B. Equipment, Material and Subcontractor Submittal Documents.

1. Submit under provisions of Section Division 1.
2. Specified Manufacturer
 - a. Manufacturers of products are listed in individual sections. Where multiple manufacturers are listed, the first manufacturer indicated has been used for the basis of the construction documents. When specific models are specified it is intended that the standard features of the specified manufacturer's model are to be included.
3. Additional Manufacturers
 - a. Additional manufacturer's, when listed, are considered to have comparable products to those manufactured by the first manufacturer listed. If the Contractor chooses to submit products manufactured by an additional listed manufacturer, it shall be the Contractor's responsibility to ensure that the products submitted are equal to the specified products.
 - b. Any changes required due to a product manufactured by an additional manufacturer other than that specified, shall be the responsibility of the Contractor and shall be at no additional cost to the Owner. Such changes include but are not limited to the following:
 - 1) Space requirements that effect architectural elements and service requirements.
 - 2) Weight requirements that effect architectural or structural elements.
 - 3) Electrical requirements that effect this and other divisions. Utility requirements.
 - 4) Anchorage requirements including seismic calculations.
4. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.
5. Mark dimensions and values in units to match those specified.
6. In addition to requirements of Division 1 include the following:
 - a. Complete bill of materials.
 - b. Highlighted cut sheets.
 - c. Blue-line shop drawings of the packaged equipment detailing field connection points.
 - d. Operating weights and seismic calculations.
 - e. Dimensions and capacities.
 - f. Wiring diagrams showing control interface.
 - g. Warranty.
 - h. Pressure drops as applicable.
 - i. Dimensional and scaled mechanical layout drawings not less than 1/4 inch equal to 1 foot. Show coordination with other trades on these layout drawings.

C. Equipment provided shall be of type and manufacture that has local representation and a local replacement and service outlet to give complete coverage on parts and service.

1.11 SUBSTITUTIONS

- A. Written requests for substitutes of material and equipment must be [submitted through a bidding contractor and] received by the Engineer no later than ten (10) calendar days prior to

bid opening. Substitutions shall be in accordance with Division 1. Requests shall be accompanied by detailed information of the proposed material or equipment.

- B. Substitution of products submitted that are not in accordance with Division 1 will be rejected and returned. Preliminary submittals for proposed substitutions will not be reviewed.
- C. Substitutions submitted that are prepared in accordance with Division 1 will be reviewed for conformance with the specified products and construction documents. Substitutions that are determined not to be in conformance will be rejected and the specified items shall be provided. Subsequent re-submittals of a substitution will not be reviewed.
- D. Substitution which are deemed to be acceptable will be included in an Addendum to the Contract Documents which will be issued before bids are due to all bidders. Acceptance of substitutes in no way relieves the Contractor of their responsibility to provide materials and equipment that adhere to the intent of the specifications and drawings, and the minimum quality set forth therein.
- E. If equipment other than that used in the design of this project is proposed to be used on this project, the Contractor and supplier shall check it for dimensional differences, electrical requirements and any other potential variances. This comparison shall be made for manufacturers named in the specifications as well as for those accepted by addendum. The contractor shall be responsible for any extra costs incurred as a result of material substitutions, including those of other contractors, such as might be involved due to different electrical requirements. The Contractor shall also compensate the Engineer for any additional engineering costs that might be incurred due to the material substitutions.
- F. Any changes required due to an accepted substitution, including Design Consultant costs, shall be the responsibility of the Contractor and shall be at no additional cost to the Owner. Such changes include but are not limited to the following:
 - 1. Space requirements that effect architectural elements and service requirements.
 - 2. Weight requirements that effect architectural or structural elements.
 - 3. Electrical requirements that effect this and other divisions.
 - 4. Anchorage requirements including seismic calculations.

1.12 SHOP DRAWINGS

- A. Submit drawings to the Engineer for review within 30 calendar days after notification of award of Contract. Shop drawings for items with critical delivery dates which could affect the progress of this project shall be submitted immediately and the Engineer notified of the need for a timely review. Otherwise, it is preferred that all shop drawings be submitted together in bound form.
- B. Carefully examine all shop drawings noting capacity, arrangement and physical dimensions and mark the drawings as being reviewed and approved prior to submitting to the Engineer. Where catalog data is submitted which includes items that do not apply to this project, those items shall be clearly marked out or relevant items clearly noted. Any deviations from the Contract Documents shall be so noted by the contractor or equipment supplier. The intent and requirements of the drawings and specifications shall be adhered to at all times and are not waived or superseded in any way by the shop drawing submittal or review.
- C. The Contractor shall verify that equipment proposed to be furnished will fit in the available space. Conflicts shall be brought to the engineer's attention prior to ordering the equipment.
- D. Each shop drawing shall include the project name, names of the Architect, Engineer, Contractor, Subcontractor, manufacturer, and supplier. Also include the name, address and telephone number of the contact representative. Each shop drawing shall clearly call out the

Section number of where the equipment is specified. Shop drawings not including the above information will be returned without review for resubmittal.

- E. ~~Submit a minimum of nine (9)~~electronic (PDF) copies of each shop drawing. ~~Unless otherwise noted, the engineer will retain one (1) copy of all shop drawings, send one (1) copy to the Owner, send one (1) copy to the Architect and return the remaining copies to the Contractor. Contractor shall retain two (2) copies~~a hard copy of all submittals on project site, which shall be incorporated in manuals of instruction as described in Part 3 of this section. Shop drawings are to be reviewed and initialed by the Engineer before purchasing equipment or before fabrication or erection of materials is started except under special circumstances as determined by the Engineer.
- F. The Engineer will require a minimum of ten (10) working days, excluding transmittal time, to review shop drawings. The Contractor shall allow for this when scheduling their work.
- G. If returned shop drawings are marked "NO EXCEPTIONS TAKEN", no additional submittals required. If marked "REVISE AND RESUBMIT", changes noted on the shop drawings are to be made and the drawings resubmitted for review. If marked "REJECTED", the equipment submitted is unacceptable and different equipment or materials need to be submitted. Only one rejected shop drawing will be returned to the Contractor. If the shop drawing is marked "MAKE CORRECTIONS NOTED", the changes noted on the shop drawings are to be incorporated, with no further resubmittal required.

~~1.13 CADD DRAWING FILES~~

- ~~A. The mechanical CADD drawing files prepared by Randall Lamb for this Project are instruments of Randall Lamb service for use solely with respect to this Project. During the course of the implementation of the Project, and with Randall Lamb approval, Others shall be permitted to obtain copies of the mechanical CADD drawing files for the preparation of Shop Drawings. These mechanical CADD drawing files shall not be used on other projects, for additions to this Project, or for completion of this Project by Others. Any intentional or unintentional revisions, additions, or deletions to these mechanical CADD drawing files shall be made at the full risk of the person(s) making such revisions, additions, or deletions, and such person(s) shall hold harmless and indemnify Randall Lamb of any and all responsibilities and liabilities.~~
- ~~B. The CD's are not to be construed as updated as-built construction documents. The CD's reflect only bidding, permit and construction documentation of original Construction Drawings. These Drawings may not include Addendums or written changes occurring during the construction process may not be incorporated into the mechanical CADD drawing files.~~
- ~~C.H. CADD drawing files of Architectural floor plans, elevations, sections, etc., shall be requested directly from the Architect.~~

~~1.141.13~~ HAZARDOUS MATERIALS

- A. No asbestos or PCB containing materials of any type shall be used on this project. The only exceptions to this are cases where acceptable substitutions have not been found for asbestos materials as in high temperature applications. If an asbestos containing material is used on this project because of that reason, that material shall be identified in shop drawings with a letter signed by a corporate officer of the manufacturer stating the reason for its use and the acceptability of that material and its use to all applicable Federal, State and Local regulations. No asbestos containing materials will be allowed on this project without such letter being submitted to and reviewed by the Engineer and the Owner.

1.151.14 ELECTRICAL POWER REQUIREMENTS AND CONTROL WIRING

- A. "Power" wiring includes line voltage wiring from distribution apparatus to motors, and to terminal boxes of 'package' equipment.
- B. "Controls" wiring includes wiring, regardless of voltage, which provides start-stop control for mechanical equipment and/or which is used to monitor functions of mechanical systems. Where line voltage wiring is extended from a local disconnecting means to relays, thermostats, by-pass timers, starter coils or the like, or from mechanical control panels or motor control centers to control devices. Such extensions are considered "controls" wiring.
- C. Unless otherwise specified, all starters, disconnects and power wiring will be furnished and installed under Division 246.
- D. All control wiring required for control of the mechanical system shall be provided as part of Division 4523.
- E. Unless otherwise specified, furnish and install all control and interlock wiring adhering with standards set forth in Division 246.
- F. Provide complete, "point-to-point" wiring diagrams for all mechanical equipment, systems and controls furnished under this division. The interface connection points between systems shall be clearly indicated on each diagram.
- G. Provide control system wiring to all equipment and control devices. Power system conduit and wiring for mechanical systems is included under Division 26.
- H. In area where the control wiring is exposed i.e. mechanical equipment and electrical rooms, inside parking garages or on the roof, it shall be installed in conduit. Do not install control wiring in same conduit with power wiring.
- I. In areas where the control wiring is in concealed spaces i.e. inside walls, above ceilings or below floors the contractor has the option not to install the control wiring conduit.
- J. Use copper conductors. Use minimum 14 AWG conductors with type THWN insulation for ANSI/NFPA 70 Class 1 circuits. For ANSI/NFPA 70 Class 2 and Class 3 circuits, use single conductors or multiple conductor cables listed for the purpose.

PART 2 - PRODUCTS

2.1 ACCESS DOORS

- A. ~~Provide access doors by Milcor or Potter Roemer.~~ Types to be as required for the surface and construction in which it is installed. Wherever volume dampers, fire dampers, controls, coils, valves, trap primers, water hammer arresters, shock absorbers, or other items or parts of the installation, which require periodic inspection or adjustment, are concealed by permanent non-removable construction, provide an access door. Verify locations with Architect/Engineer.
- B. Label duct access doors as to its use, e.g. "Fire Damper", etc.
- C. Size for proper access, adjusting and maintenance:
 - 1. 12 in. x 12 in. minimum for valves, trap primers, shock absorbers, etc.

2. 24 in. x 24 in. for man access to concealed fans, coils, etc., unless indicated otherwise.

2.2 ACCESS TILE IDENTIFICATION

- A. Buttons, tabs, and markers: to identify location of concealed work, valve access, filter access etc.
- B. Submit to architect, engineer, and owner for review.

PART 3 - EXECUTION

3.1 INSTALLATION OF WORK

- A. Arrange work symmetrically to building lines, lights, and tile pattern in the most direct, straight and mechanical manner possible and properly graded. Lay out work and provide offsets; conform to structure; avoid obstructions; preserve headroom; and keep openings and passageways clear.
- B. Where piping/ductwork heights are not indicated, provide a minimum clearance of 7 feet from floor to the bottom surface of work (including insulation) in mechanical areas.
- C. Ensure that work is quickly and easily accessible. Locate the portions of systems above ceilings requiring maintenance where service can be accommodated directly from a ladder. Reaching across obstructions such as other piping, light fixtures, or casework is not acceptable.
- D. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Architect/Engineer before proceeding.
- E. Install piping, ductwork, and equipment so it does not enter or pass through electrical spaces and rooms. Exception: 1) ducts and fire sprinklers serving this room only, 2) should piping pass through an electrical space it shall not encroach upon clear area over electrical equipment and shall have drip pans or other form of acceptable double containment.

3.2 EQUIPMENT CLEARANCE

- A. The Contractor shall not install ductwork and/or piping for heating, refrigeration, plumbing, fire protection, process piping or any other piping systems which is located in the manufactures recommended service clearance area of any mechanical, electrical or plumbing systems.

3.3 HAZARDOUS MATERIALS

- A. No asbestos containing materials of any kind shall be removed by the Contractor or any of their Subcontractors. If asbestos containing materials are suspected, the Contractor shall immediately notify the owner who shall employ the services of an independent testing laboratory to test the suspect material. If the results of such tests positively identify the material as containing asbestos, the Owner shall employ the services of an approved asbestos abatement contractor to remove the asbestos material as deemed necessary for the safety and well being of building occupants and construction workers.
- B. Any trades working around any asbestos or asbestos containing materials shall take extra caution not to disturb those materials. If this does not appear to be possible, the materials shall be requested to be removed. Such requests shall be made to the Owner in a timely

fashion so as not to delay the project. If the Contractor claims that delay and additional cost is involved because of this action, he shall make such claim immediately with a full explanation of the reason for the required delay and/or extra costs. Such claims will be reviewed by the Owner, Architect and Engineer for their acceptability.

3.4 SAFETY REQUIREMENTS

- A. The Contractor shall be responsible for initiating, maintaining and supervising all safety precautions required in connection with their work, including regulations of the Occupational Safety and Health Administration (OSHA) and other governing agencies.

3.5 FIRE SAFETY PRECAUTIONS

- A. The Contractor shall provide adequate protection to all areas where cuttings, welding, brazing and sweating operations are performed in the vicinity of or accessible to combustible material to make certain that sparks or hot slag does not reach the combustible materials and thus start a fire.
- B. When it is necessary to do cutting, welding, brazing or sweating close to wood construction, in pipe shafts, or other locations where combustible materials cannot be removed or adequately protected, the employer shall employ adequate protection to those areas such as fire blankets and proper fire extinguishers. In addition, Contractor shall utilize a workman solely on fire watch at each different location on the site. No such work will be allowed within two hours of the end of the working day.

3.6 SMOKE DETECTOR SYSTEMS

- A. In buildings with fire alarm systems or elevator recall systems, the Contractor shall closely coordinate their work with the Owner so that their work does not disrupt that system.
- B. Where the Owner has existing procedures on fire alarm shutdown or elevator recall systems, the Contractor shall abide by those procedures.
- C. Where the Owner has no set procedure on fire alarm shutdown, the contractor shall request a meeting with the Owner, Architect and Engineer to determine the fire alarm shutdown procedure for this project.
- D. No fire alarm systems are to remain inactivated at the end of the work day. It is the Contractor's responsibility to assure that any fire alarm systems deactivated for their work are reactivated before completing their work day.

3.7 INSPECTIONS

- A. Regular inspections shall be requested by each Contractor as required by any and all governing agencies. Charges for inspections by regulating agencies of installations or plans and specifications shall be paid by the Contractor.

3.8 COORDINATION

- A. Consult the Contract Drawings and Specifications of Division 26 and other trades for correlating information and layout work so that it will not interfere with other trades. Verify all dimensions and conditions; i.e., finished ceiling heights, footing and foundation elevations, beam depths, etc., with architectural and structural drawings. If conflicts occur such that resolution is not possible by the affected trades on the job, the engineer or architect shall be notified and a resolution will be worked out. Where work must be replaced due to failure to verify conditions existing on the job, such replacement shall be accomplished at no extra cost to Owner. This shall apply to shop fabricated work as well as work fabricated in place.

- B. The Contractor shall make all connections at the terminal points of the Contract. Piping, ductwork, equipment, etc. may be shown with excess clearances for clarity. Group pipe and arrange piping, ducts, and equipment to present a neat appearance and to avoid blocking passageways while allowing sufficient space for operation of valves, cleaning strainers, etc. The piping that is to be insulated shall be insulated individually with the covering extending completely around each pipe without a reduction in thickness while maintaining a separation or gap between piping, ducts, etc.
- C. The General Contractor will be required to leave all chases and openings in walls, floors, ceilings and partitions, where shown on drawings or otherwise necessary to receive mechanical work (except in pre-poured concrete wall and floor panels). This Contractor shall furnish him full information as to locations and dimensions of such chases and openings, including provision and proper setting of sleeves and other equipment in such time as to cause no delay to work of General Contractor.
- D. Should any cutting of walls, floors, ceilings, partitions, etc. be required for proper installation of the work or apparatus of this Contractor or be necessary due to their failure to give the General Contractor proper information at the time required, such cutting as well as any work required to return the work to its original condition shall be done at this Contractor's expense.
- E. All cutting and patching done by this Contractor shall be subject to the direction and approval of the Architect and Engineer. This Contractor shall not endanger the stability of the structure by cutting, digging, or otherwise affecting it. Also, this Contractor shall not at any time cut or alter any work of other contractors without consent from the Architect or Engineer. Do not cut or install anything in prestressed or post-tension concrete floors or other structural members without consulting the Project Structural Engineer.
- F. It is the intent of these plans and specifications that most piping and ductwork will be concealed. Where they are exposed, they shall be run as close to ceilings and/or walls as possible and installed parallel with adjacent structural or architectural elements. Minimize number of fittings and joints in exposed piping. Clean and test all piping before insulating and concealing it.
- G. Coordinate work with that of other trades, properly grouping piping with other piping, conduit and ductwork. In general, piping and ductwork is shown on drawings as intended to be installed, but many times these items are shown schematically for clarification and without every rise and offset required during the actual installation. Install piping and ductwork as necessary to accommodate the building structure and components of other trades, providing a reasonable number of offsets as necessary, without extra cost to the Owner.
- H. Do not scale from drawings but rather take measurements at the building site to properly locate work.
- I. Ceiling and shaft spaces require close coordination. ~~Therefore, the following procedure shall be followed:~~ The contractor shall follow the coordination requirements set forth in section 01 31 00 – Project Management and Coordination.
- ~~1. The HVAC/Sheet Metal Contractor shall initiate the coordination process by showing all ductwork on a reproducible drawing or CADD which has a scale of not less than 1/4" = 1' 0" for sections and 1/4" = 1' 0" for plans.~~
 - ~~2. The drawings shall be forwarded to the general, electrical, fire protection and plumbing contractors (including, but not limited to, plumbing, fire protection, medical gas, electrical, etc.) for inclusion of their work.~~

- ~~3. The Contractors shall solve all coordination conflicts between themselves when possible. The Engineer will arbitrate when necessary and their judgement will stand, with no additional cost to the project.~~
- ~~4. Where obvious lack of interference occurs, the Contractor(s) need only sign off that their work will not cause interference, and therefore, will not be required to include their work on the coordination drawing.~~
- ~~5.1. The project contractors shall produce these coordination drawings in the same format, hand drawn, CADD, etc. They shall meet and determine the format before beginning the coordination drawing process. The Owner will not pay any additional costs due to format issues.~~

3.9 PAINTING

- A. Paint bare piping, equipment, piping insulation, equipment insulation, ductwork, hangers, supports, and other mechanical work exposed to weather and within the mechanical rooms/areas, crawl spaces, and tunnels. ~~Preparation~~
 1. Thoroughly clean all parts of mechanical work. Thoroughly clean exposed parts made of cement, plaster, and other materials, which are to be painted. Remove oil and grease spots. Carefully wipe such surfaces. Scrape out cracks and corners. When project is turned over to the Owner, the faces of the inlets/outlets shall be thoroughly clean.
 2. Brush down exposed metal work with steel brushes to remove rust and other spots. Leave smooth and clean.
- B. Provide 1 prime coat and 2 finish coats.
- C. Factory finished equipment need not be painted. Touch up damaged surfaces.

3.10 INTERRUPTION OF SERVICE UTILITIES

- A. Schedule work in such manner as to avoid if at all possible any services to any portion of the existing building unless such disruption is first cleared with the Owner's appointed representative. Locate main shut-off valves on systems before performing any work on those systems.
- B. Schedule and coordinate interruptions of utilities with the Architect/Engineer and Owner within 30 days after award of contract. Submit to the Owner a schedule of proposed interruptions. At least 72 hours prior to an interruption, submit a request indicating:
 1. Proposed date and duration of interruption.
 2. Work to be accomplished.
 3. Areas which will be affected.
 4. Contingency plan to be followed in the event that normal service or facilities cannot be restored on schedule.
- C. Do not proceed without written permission from Architect/Engineer and Owner.
- D. Provide labor and materials necessary to restore services on a contingency basis should normal service or facility not be restored on schedule.
- E. Perform preparatory work associated with each interruption during normal work hours.

- F. Subject to conditions outlined in Division 01, Perform work resulting in interruption of the following systems between 7 p.m. and 5 a.m. Maximum shutdown during this period of systems shall be 10 hours.
1. Air handling.
 2. HVAC piping.
 3. Sewer.
 4. Medical gases.
 5. Domestic and industrial water.
- G. Drain and refill piping systems as required to accommodate connections to these utility systems.
- H. Provide additional chemical water treatment as necessary to maintain proper water quality.

3.11 FUTURE ADDITIONS

- A. Valve and cap piping and ductwork for future extension as shown on the drawings. If areas are discovered where fixtures are not shown on the drawings, immediately bring such discoveries to the Owner's attention.
- B. If piping or ductwork for future extension are on system to be insulated, the valve and caps or duct taps shall be insulated as specified for the systems to which these extensions are installed.

3.12 CONNECTIONS TO EXISTING BUILDINGS

- A. Connect to existing building systems as shown on the drawings. Any existing equipment and/or systems affected by these connections shall be placed into proper operation. Add isolation valves at point of connection to existing services.

3.13 PROTECTION

- A. Cover openings and equipment, where set, to prevent obstruction to pipes, breakage, misuse or disfigurement of equipment. Cover openings in equipment immediately upon uncrating or receipt at the job site. The openings shall remain covered until permanent connection is made and/or the equipment is put into operation.
- B. Contractor shall be responsible for all work, materials, and equipment until finally inspected, tested, accepted by the Owner. Protect work from theft, injury or damage.
- C. The Contractor shall keep clean all materials installed by him until final acceptance of the entire building by the owner. The Contractor shall be responsible for properly covering and protecting the equipment from damage due to water, spray-on fireproofing, construction debris, etc.
- D. When a portion of the building is to be occupied by the owner prior to substantial completion of the entire project, the Contractor shall retain the responsibility for protection and housekeeping tasks until the equipment and/or system is fully accepted by the Owner or Engineer.

3.14 ELECTRICAL EQUIPMENT AND ELECTRICAL ROOM PRECAUTIONS

- A. In general, the Contractor shall not install ductwork and/or piping for heating, refrigeration, plumbing, fire protection, process piping, or any other piping systems in a room housing switchgear or transformers, elevator equipment, telephone, or electrical equipment unless it directly serves that room. Exception: 1) should piping pass through an electrical space it

shall not encroach upon clear area over electrical equipment and shall have drip pans or other form of acceptable double containment.

- B. In no case shall piping be installed above switchboards, panelboards, control panels, motor control centers, individual motor controllers, etc.

3.15 CLEANING UP

- A. Keep the premises free from accumulations of waste materials or rubbish caused by execution of the work. At the completion of the work, remove all rubbish, tools, scaffolding, surplus materials, etc. from and about the premises. The premises shall be "broom-cleaned" or its equivalent, unless more exactly specified. In case of dispute, the Owner may remove the rubbish and charge the cost to the Contractor as the Engineer shall determine to be just.
- B. Remove labels from plumbing fixtures and other equipment with the exception of those required by U.L., FM, ETL, or other testing laboratories and those required by this specification.

3.16 INSTALLATION PROCEDURES

- A. The Contractor shall install all material and equipment in accordance with the manufacturers' printed recommendations and instructions except where revised on the contract documents. The Contractor shall maintain copies of the printed manufacturer's installation instructions on the site for review as required.
- B. Install equipment and materials to provide required access for servicing and maintenance. Coordinate final equipment location with required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

3.17 RECORD DRAWINGS

- A. Contractor shall obtain a set of construction drawings for sole purpose of recording all work, which is installed differently from that, indicated on the contract drawings.
- B. Provide and maintain on the job, a complete set of prints of the drawings for ~~the~~ Division 22, 23, and 26-45 work. On this set of prints as work progresses locate all work dimensionally from fixed points. All deviations of more than one foot shall be indicated. Record all changes or deviations from the contract drawings as follows:
 - 1. All deviations shall be indicated with reference to building lines, curbs, walk ways and other permanent features.
 - 2. Record exact location and elevation of sanitary and storm sewers, including manholes, cleanouts and changes in direction.
 - 3. Record above information for all other underground mechanical services, including refrigeration piping, domestic water, steam and gas.
 - 4. Record routing of concealed and exposed above ground piping on each floor where it varies from the contract drawings including the depth of capped pipes and existing pipes discovered.
 - 5. Indicate routing of ductwork including fittings, offsets, depth of plugged wyes and tees, and existing ducts discovered.
- C. Keep drawings continuously up-to-date, neat, legible, and make available for inspection at all times. Indicate existing lines discovered on these drawings.

- D. Upon completion of work, provide two (2) bond sets of these drawings. Sign and date the drawings as to their accuracy.
- E. Contractor shall turn over this set of drawings to the Architect/Engineer and in accordance with Division 1 and this Section.
- F. The Engineer reserves the right to withhold payment applications if record drawings are not being maintained to their satisfaction.

3.18 GUARANTEE INSTRUCTION

- A. The Contractor shall warranty all work and materials for the minimum period of one (1) year, except where a longer period of time is specified elsewhere, after completion of the work and final acceptance by the Owner and Engineer. Any warranties such as "one (1) year after start-up or eighteen (18) months after shipment" proposed by an equipment supplier or Contractor is not acceptable.
- B. Defects of any kind due to faulty work or materials appearing during the above-mentioned period must be immediately made good by the contractor at their own expense to the entire satisfaction of the Owner and Architect and Engineer. Such reconstruction and repairs shall include all damage to the finish or furnishings of the building resulting from the original defect or repairs thereto.
- C. This guarantee shall not apply to damage occurring after final acceptance and due to wind, fire, violence, abuse or carelessness of other Contractors or their employees or the agents of the Owner.

3.19 START-UP OF SYSTEMS

- A. All equipment prior to start-up shall be fully lubricated, charged, filled, etc., per manufacturer's recommendations. All bearings and other machine parts requiring lubrication shall have an accessible means for lubrication. Where lubrication fittings on equipment or parts are concealed and/or not easily accessible, extend the fittings to an accessible position (accessible without the opening of an enclosure, etc.) using galvanized pipe or copper tubing. Properly identify each grease fitting which is remotely situated with the part to be lubricated i.e. fan bearing, motor bearing, etc. Install "Zerk" type grease gun fittings on all equipment requiring greasing.
- B. Prior to final review of mechanical systems, each system shall be run through all operating modes to verify proper operation. After the contractor has verified that all systems are operating properly, he shall notify the engineer in writing that all systems are functioning properly, including the date and method of testing in the notification.
- C. After proper operation has been verified for each system, instruct the owner's designated personnel in the operation of each mechanical system immediately prior to acceptance by Owner. Present to the Owner for their signature a form that includes the system operated, date of instruction, and Owner's and contractor's personnel present. Give copy of signed form to Owner and send copy to the Architect and Engineer.

3.20 FINAL INSPECTION

- A. A final inspection of the mechanical systems will be required before the project can be closed out. When the Contractor feels that all systems are fully completed and operational, he shall request that a final inspection be performed by the Engineer. The Engineer will then schedule an inspection and generate a list of items that need to be corrected or completed before project closeout.

- B. If the Engineer is requested to make a final inspection by the contractor, and the Engineer finds the work is not complete enough to perform that inspection, the Contractor will compensate the engineer for their additional inspection. The Contractor will then perform the necessary work to complete the project and again request a final inspection.

3.21 OPERATING INSTRUCTIONS, SERVICE MANUAL AND OWNER TRAINING

- A. Before final payment is made, assemble and deliver to the engineer for their review four (4) sets of Operation and Maintenance Manuals, which includes all equipment and materials furnished under this division. Submit information in a 3-ring hard cover binder with all data organized according to Section numbers and indexed accordingly.
- B. Submit for approval immediately upon completion of the work.
 - 1. Include the following items together with other pertinent data:
 - a. Identifying equipment name, equipment locations and tag numbers.
 - b. Manufacturer's Literature: Copy of manufacturer's instructions for operation and maintenance of mechanical equipment, including replacement parts, lists, and drawings. Submit these brochures and other required operating and service instructions. Mark brochure literature indicating the model, sizes, capacities, curve operating points, etc., in a manner to clearly indicate the equipment installed. Remove pages or sheets from the bulletins and catalogs that do not pertain to equipment installed on the project.
 - c. Oiling, lubrication, and greasing chart.
 - d. Complete nameplate data and test data on equipment.
 - e. Belt sizes, types, and lengths.
 - f. Serial numbers of principal pieces of equipment.
 - g. Manufacturer's suppliers and subcontractors names, addresses, and phone numbers.
 - h. Wiring diagrams.
 - i. Control diagram and written sequence of operation.
 - j. Performance curves and data.
 - k. Written guarantee.
 - l. Record As-builts and Shop Drawings corrected and completed to date. Furnish with sheet index.
 - 2. Written Instructions: Typewritten instructions for operation and maintenance of the system composed of operating instructions, maintenance instructions, and maintenance schedule.
 - a. Operating instructions: Provide brief description of the system. Do not include adjustments requiring the technical knowledge of the service agency personnel. Note that such adjustments are required.
 - b. Maintenance instructions: List each item of equipment requiring inspection, lubrication, or service. Describe the performance of such maintenance.
 - c. Maintenance schedule: List each item of equipment. Show the exact type of bearing on every component of each item of equipment. Show when each item of equipment should be inspected or serviced.
- C. Provide direct instruction. ~~Instruction shall consist of a minimum of [2] formal [4] hour periods over consecutive days and shall be 30 percent classroom and 70 percent at site location.~~ Schedule with Owner's Representative. Submit written agenda for review and comment 2 weeks prior to instruction. Provide provisions for up to 5 of the Owner's staff members. Provide visual aids, supplies, and literature as required. ~~Record each session on videotape and give 2 copies of each video-recorded session to the Owner within 30 days of instruction. Provide auxiliary lighting as necessary for clear recording.~~

END OF SECTION

SECTION 23 05 10

SUPPORTS, ANCHORS AND SEALS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Pipe hangers and supports
- B. Duct hangers and supports
- C. Equipment bases and supports
- D. Flashing for mechanical equipment
- E. Sleeving for mechanical equipment

1.2 REFERENCE STANDARDS

- A. Pipe Supports: Manufacturers' Standardization Society Specification SP-69, "Pipe Hangers and Supports - Selection and Application"
- B. Pipe Supports: ANSI B31.1 "Standard Code for Pressure Piping."
- C. Duct Hangers: SMACNA Duct Manual HVAC Construction Standards – Metal and Flexible
- D. OSHPD – Pre-approval program.

1.3 SUBMITTALS

- A. Submit shop drawings for all equipment provided under this section.

1.4 DESIGN REQUIREMENTS

- A. Provide intermediate structural members between joists or beams to support work where floor/roof deck cannot support work.
- B. Provide calculations by a structural engineer registered in the State of California where necessary to accommodate support of piping, ductwork, and equipment and where necessary for approval of governing authorities.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Hangers: B-Line Systems, Grinnell, Tomarco, Isat, Tolco, Mason Industries.
- B. Pipe Riser Clamps: Grinnell, B-Line Systems, Tolco.
- C. Seals: PSI Link-Seal or approved equal.

- D. Firestop material for penetration of construction: Flameseal Putty, Dow Corning 3-6548 RTV Foam, 3M Caulk CP-25, 3M MP-1 or MP-2 Moldable Putty, Tremco.
- E. Expansion anchors: Hilti or approved equal.
- F. Powder driven fasteners: Hilti or approved equal.
- G. Channel Framing: Unitstrut Metal Framing, Tolstrut by Tolco, B-Line.

2.2 INSERTS

- A. Malleable iron concrete insert to provide a threaded connection with lateral adjustment. The insert yoke shall allow reinforcing rods to pass through the top of the insert. To be used for piping 8 inches and smaller. Equal to Grinnell Figure 282.
- B. For piping larger than 8 inches: Equal to Grinnell Figure 66 attachment welded to a steel plate (size as determined by ~~installer~~ structural engineer referenced in section 1.4.B) and supported at each corner by a concrete insert equal to Grinnell Figure 282.

2.3 PIPE HANGERS AND SUPPORTS

- A. All piping shall be thoroughly and substantially supported with approved hangers. The design, selection, spacing, and application of horizontal pipe hangers, supports, restraints, anchors, and guides shall be in accordance with applicable standards. The Power Piping Code ANSI B31.1 shall take precedence over the MSS SP-69 Standard.
- B. Support horizontal piping with adjustable clevis hangers, equal to Grinnell Fig. 260, with locking nuts above and below the clevis. On insulated pipe where hanger comes in contact with the piping, use clevis hanger equal to Grinnell Fig. 300. Provide copper plated hanger for support of copper piping where hanger comes in contact with piping.
- C. Support horizontal piping subject to expansion with adjustable roller hangers equal to Grinnell Figure 181 or Figure 177.
- D. All vertical pipes not specified to be supported on vibration isolation hangers shall be supported as follows:
 - 1. All vertical cast iron soil piping shall be supported as follows:
 - a. 10" and smaller piping shall be supported at every floor with a two (2) bolt riser clamp designed for the load and manufactured by B-Line Systems (similar to B-Line B3373) or approved equal.
 - b. All piping 12" and larger shall be supported at every floor with a four (4) bolt riser clamp designed for load and manufactured by B-Line Systems (similar to a B-Line B3134) or approved equal.
 - c. Any welding, extensions or modifications of the riser clamps shall be reviewed by the Project Structural Engineer.
 - 2. All other vertical piping 6" and smaller shall be supported at least every other floor with a minimum of two (2) bolt riser clamps designed for the load and manufactured by B-Line (similar to a B-Line B3373). All vertical pipes from 8" in diameter up to and including 12" in diameter shall be supported at least at every other floor with a minimum of four (4) bolt riser clamps (two (2) bolts on each side), designed for the load and manufactured by B-Line (similar to B-Line B3134), or approved equal riser clamps. Any welding, extensions or modifications of the riser clamps shall be reviewed by the Project Structural Engineer.

3. Vertical pipes 14" in diameter and larger shall be supported at least at every other floor, with structural steel channels and gussets welded to the pipe. Structural steel supports shall be provided by this Division and they shall be reviewed by the Project Structural Engineer.
- E. All vertical pipes requiring vibration isolation shall have spring isolators as specified in Section 23 05 48, Vibration Isolation and Seismic Restraints. Riser clamps and steel channel supports shall be as specified herein and indicated on the drawings with provisions for attachment to the vibration isolators.
- F. Refer to Section 15410 entitled "Plumbing Piping" for plumbing piping anchor requirements.

2.4 HANGER RODS

- A. Provide threaded steel hanger rods, sized and installed as ~~recommended~~ calculated by ~~hanger manufacturer~~ structural engineer referenced in section 1.4.B for service intended.
 1. Hanger rods used in areas of moisture laden air, such as penthouses, shall be stainless steel.

2.5 DUCT HANGERS AND SUPPORTS

- A. Hangers: Galvanized steel band iron or rolled angle and 3/8 inch diameter rods. All fastenings and hardware shall be cadmium plated or stainless steel.
- B. Wall Supports: Galvanized steel band iron or fabricated angle bracket.
- C. Vertical Support at Floor: Rolled angles.
- D. Hangers and wall supports in areas of moisture laden air shall be aluminum or stainless steel, including fastenings and other hardware.

2.6 FLASHING

- A. Steel Flashing: 26 gauge galvanized steel.
- B. Lead Flashing: 4 pounds per square foot sheet lead for waterproofing, 1 pound per square foot sheet lead for soundproofing.
- C. Safes: 5 pounds per square foot sheet lead or 8 mil thick neoprene.
- D. Caps: 22 gauge galvanized steel or 16 gauge at fire resistant structures.
- E. Flexible Flashing: 47-mil thick sheet butyl, compatible with roofing.

2.7 SLEEVES

- A. Pipe sleeves through floor slabs, masonry or brick partition walls, and exterior building walls above and below grade shall be standard weight black steel pipe, fabricated of new material, cut square and reamed.
- B. Pipe sleeves through roof slabs shall be constructed of 22 gauge galvanized iron.

2.8 PIPE ANCHORS

- A. Channel and I-beam, pre-insulated anchor carbon steel, powder coat finish, calcium silicate insulation insert 900 psi compressive strength, support working loads up to 17,500 pounds. ~~Metraflex model PAPI.~~

2.9 SEALS

- A. Where water, gas or oil lines pass through sleeves in building walls below grade, provide a modular wall seal, ~~equal to Link Seal, as manufactured by PSI.~~

2.10 EXPANSION ANCHORS

- A. Expansion anchors shall be stud or shell type. Stud type expansion anchors shall meet chemical requirements for ASTM Specification A108, be plated in accordance with the requirements of ASTM B633, and meet the dimensional requirements of Federal Specification FF-S-325, Group II, Type IV, Class I. Also stud type anchors shall have independent expansion wedges made from spring steel. Stud type expansion anchors shall be equal to Hilti Kwik Bolts. Shell type anchors shall be plated in accordance with the requirements of, ASTM B633, and shall be manufactured with an internal expansion plug to prevent incomplete setting of the anchor. Shell type anchors shall be equal to Hilti HDI.

2.11 CHANNEL FRAMING

- A. Factory fabricated cold-formed steel channels and accessories.
- B. Materials:
1. Channels – $F_y = 33,000$ pounds per square inch minimum.
 2. Plate Fittings – ASTM A635.
 3. Bolts, Nuts, and Screws – ASTM A307 or equivalent.
- C. Sizes, Dimensions, and Properties:
1. Channels – 1-5/8-inch, 12-gauge series with properties per table.
 2. Fittings – 1/4-inch thickness with 9/16-inch holes for bolts. Hole spacing at 1-7/8 inches and 13/16 inches from end.
 3. Bolts – 1/2-inch diameter.
 4. Nuts – Serrated channel type for positive grip.
- D. Finishes: Parts, bolts, and nuts electrolytically coated with zinc to commercial standard ASTM-B633, Type 111 SCI.
- E. Installation: Use components as provided from factory without alteration except channels may be field cut to length with power saw. Erect plumb and true to lines. Torque bolts to 50 foot pounds.

CHANNEL PROPERTIES

MK	SIZE	AREA(IN ²)	WT(LBS)	X AXIS S(IN ³)	Y AXIS S(IN ³)
Single Channel B-22	1-5/8 x 1-5/8	.559	1.9	.2042	.2880
Double Channel B-12A	1-5/8 x 4-7/8	1.453	4.94	1.153	.824
S-Modulus					

PART 3 - EXECUTION

3.1 GENERAL

- A. Fabricate and support ductwork and piping in accordance with specifications herein, and latest edition of CMC and CPC. Provide seismic restraint in accordance with a current OSHPD pre-approved system that carries a current OSHPD OPA Number. For seismic restraint, see Section 23 05 48.

3.2 DRILLING OF CONCRETE SLABS OR BEAMS

- A. No drilling of holes will be allowed in concrete joists, all holes will be in slab pan area of floor system.

3.3 HAMMER DRILLS

- A. No drilling with hammer drills will be allowed in existing hospital buildings, unless special permission is granted by the Facilities Engineering Department.

3.4 INSERTS

- A. Where possible, use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- B. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 4 inches in diameter or duct over 60 inches wide.
- C. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
- D. Where inserts are omitted, and after locating cables or reinforcing rods, drill through concrete slab from below, and provide rod with recessed square steel plate and nut above slab.

3.5 PIPE HANGERS AND SUPPORTS

- A. Support horizontal steel and copper piping with maximum spacing and location per California Plumbing Code, Latest Edition, and as follows:

Nominal Pipe	Hanger Rod
Size (In.)	Diameter (In.)
1/2 & 3/4	3/8
1 to 1-1/2	3/8
2 & 2-1/2	1/2
3 & 4	5/8
5 to 12	7/8
14 to 18	1

- B. Support horizontal cast iron waste, vent and storm piping with maximum spacing and location per California Plumbing Code, Latest Edition, and as follows:

Nominal Pipe	Hanger Rod
Size (In.)	Diameter (In.)
2	1/2
3 and 4	5/8

6 to 12	3/4
14 to 18	3/4

- C. Provide additional supports for valves or other concentrated loads between supports.
- D. Except where trapeze hangers are used to support piping, all piping and ductwork shall be individually supported. Do not support ducts or pipes from other pipes, ducts, equipment or conduit.
- E. Install hangers to provide minimum 1/2 inch clear space between finished pipe insulation and adjacent work.
- F. Place a hanger within one foot of each horizontal elbow.
- G. Use hangers that are vertically adjustable 1-1/2 inch minimum after piping is erected.
- H. Support vertical piping at every floor and base. Support vertical soil pipe at base and each floor at hub.
- I. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- J. Where practical, support riser piping independently of connected horizontal piping.
- K. Hangers for insulated pipe shall be large enough to encompass the insulation and the metal protection shield, except that hangers may be applied directly to the pipe for domestic hot water and rainwater piping systems.
- L. Provide hanger spreaders on hangers for pipes 4 inches and larger.

3.6 INSULATION PROTECTION AT PIPE HANGERS

- A. On hot piping, where the hanger is specified to fit outside of the pipe insulation, provide a piece of calcium silicate insulation on the bottom 180 degrees of the piping at the hanger, with fiberglass insulation on the upper half. The calcium silicate section shall be 2 inches longer than the metal shield beneath it.
- B. Shield insulation shall be galvanized steel, 16 gauge for piping smaller than 4 inches, 14 gauge for piping 4 inches and larger and shall span an arc of 180 degrees. Lengths of shields shall be as follows:

Pipe Size	Shield Length
Up to 6"	12"
8" - 12"	16"
Over 12"	20"
- C. On cold and chilled water piping provide corrosion resistant perlite block insulation at hanger points. See specification Section 23 07 10 entitled "Mechanical Insulation". Insulation jacketing shall be sealed where cut to install the perlite block.

3.7 PIPE ROLLERS

- A. Where thermal movement causes the hanger rod to deviate more than 4 degrees from the vertical or where longitudinal expansion causes a movement more than 1/2 inch in the pipe, provide roller hangers. This is only required with hot insulated piping. Provide saddles at

pipe roller supports, welded to the piping and of sufficient length to maintain contact at roller supports at all conditions of pipe movement.

- B. ~~Provide pipe roller support for the emergency generator muffler and exhaust pipe to allow for expansion.~~

3.8 DUCT HANGERS AND SUPPORTS

- A. Ductwork shall be supported in accordance with standards published by SMACNA.

3.9 EQUIPMENT BASES AND SUPPORTS

- A. For mechanical equipment, provide reinforced concrete housekeeping bases poured directly on structural floor slab, 4 inches thick nominal, extended 6 inches minimum beyond machinery bedplates. Provide templates, anchor bolts and accessories required for mounting and anchoring equipment.
 - 1. Concrete equipment bases will be provided by General Contractor, but supplier of equipment shall furnish anchor bolts and sleeves, properly laid out for the equipment being furnished.
- B. Where mechanical equipment is to be mounted above a concrete base, on a wall or suspended above a space, provide supports as required of structural steel members, braced as necessary to provide rigidity.

3.10 FLASHING

- A. Flash and counterflash where mechanical ductwork and piping pass through weatherproofed or waterproofed walls, floors or roofs.
- B. Flash floor drains and roof drains as described in Section ~~15435~~^{22 13 19}, ~~Plumbing-Sanitary~~ Drainage Specialties. Solder at joints, flash into floor drains and turn up 6 inches into walls or top of curbs and caulk into joints where they occur, such as at mop sinks and shower drains above grade. Seal floor, shower, and mop sink drains watertight to adjacent materials.
- C. Flash vent and soil pipes projecting 3 inches (minimum) above finished roof surface with lead worked a 1-inch minimum into hub, 8 inches (minimum) clear on sides with 24 by 24 inch sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.
- D. Provide curbs for mechanical roof installations 8 inches minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight.
- E. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.
- F. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.
- G. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.11 SLEEVES

- A. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.
- B. Pipe sleeves through slabs, walls and partitions shall be 1/2 inch greater in inside diameter than external diameter of pipe or insulated cold piping. All sleeves shall be fabricated of new material, cut square and reamed.
- C. Sleeves through masonry partition walls shall extend through full thickness of wall, and shall be flush with finished surfaces.
- D. Sleeves through exterior building walls above grade shall be standard weight black steel pipe installed flush with finished surfaces and caulked between sleeves and pipe with oakum and lead to provide watertight joint. Sleeves to have anchoring flange imbedded in masonry wall.
- E. Sleeves through exterior walls below grade shall be standard weight black steel pipe with Link-Seal. Sleeve diameters shall be as recommended by manufacturer.
- F. Sleeves through floor slabs in exposed areas shall extend 1 inch above the finished floor surface. Sleeves in mechanical room floor slabs shall extend 6 inch above the finished floor surface.
 - 1. Where piping or ductwork passes through floor, ceiling or wall, close off space between pipe or duct and sleeve or construction with Link-Seal.
- G. Sleeves shall be set and maintained in place by this Contractor during progress of the work. Cutting of new floors will not be permitted.

3.12 PENETRATION OF CONSTRUCTION

- A. Where piping and ductwork pass through floor, ceiling or wall and a fire separation is required, close off space between pipe and sleeve or construction with a firestop material. This firestop shall be a UL rated and FM approved penetration system.
- B. Where a fire separation is not required, pack spaces between piping and ductwork and construction with a non-combustible plastic material flush with surface of floor or wall to provide a waterproof joint to prevent sound transmission, and to prevent air transmission.

3.13 EXPANSION ANCHORS

- A. Install in accordance with manufacturer's recommendations.

3.14 PIPE ANCHORS ABOVE GRADE WITHIN BUILDING

- A. Weld structural anchor steel to steel pipe. Securely clamp structural anchor steel to copper pipe. Both of these anchoring arrangements shall restrict movement of piping in all directions. To resist forces in all directions provide diagonal support members as required. Structural loading is to be based on thermal expansion forces. Secure steel anchor members to the surrounding prime building structural steel. Anchor locations are as indicated on drawings.

3.15 ROOF MOUNTED PIPING AND DUCTWORK

- A. Provide supports as required and at elbows.
- B. The distance between supports as specified unless otherwise shown.
- C. Provide curbs where piping and single ducts penetrate the roof unless otherwise shown.
- D. Provide pre-manufactured curb strips for supporting ductwork and piping unless otherwise shown.

3.16 ROOF MOUNTED EQUIPMENT

- A. Base mounted equipment shall be curb/platform mounted unless otherwise noted. Anchor equipment to these curb/platforms unless otherwise shown.

3.17 UPPER ATTACHMENT

- A. Concrete (with or without metal deck):
 - 1. For the upper attachment to concrete filled metal deck, attachment shall only be made to the bottom of the metal flute where the concrete is the thickest, unless otherwise shown.
 - 2. Where weight of supported work exceeds structural limits of the deck, do not attach to the underside of concrete filled metal deck. Provide intermediate structural steel between the prime structure to support work.
 - 3. See structural drawings for the limitations of upper attachments to the floor/roof deck assemblies.
 - 4. Span across the bottom of metal deck flutes where necessary.
 - 5. Pigtail hanger straps for ductwork to be per SMACNA.

3.18 PIPING ALONG FLOOR AND WALL (2 INCHES AND LESS)

- A. Provide channel framing and clamping hardware to secure piping from movement unless otherwise shown.

3.19 SUSPENDED EQUIPMENT

- A. Provide 4 point hangers with seismic sway bracing and rod stiffeners see structural drawings and section 23 05 48 Vibration Isolation and Seismic Restraint.-

END OF SECTION

SECTION 23 05 13
MOTORS AND DRIVES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Electric motors ~~and drives~~ as required for equipment furnished under this Division.
- B. Power factor correction as required for equipment furnished under this Division.

1.2 PROPOSALS: The supplier shall submit a list of exceptions to the contract specifications with his proposal.

1.3 SUBMITTALS

- A. Provide shop drawings on all motors including manufacturer and nameplate data.
- B. Where motors are used with variable frequency drives, shop drawings shall indicate motor's compatibility with variable frequency drive systems being provided with this Project, including the ability to operate those motors at a reduced fixed speed without a reduction in motor or bearing life.
- C. Provide shop drawings and selection data for power factor correction capacitors.
- D. Refer to Section 23 05 00 entitled "General Provisions" for shop drawing preparation requirements.

1.4 QUALITY ASSURANCE

- A. Motors to conform with NEMA standard enclosures, voltages and mounting configurations.
- B. Motors shall conform to construction and installation requirements of National Electrical Code and explosion proof motors shall be Underwriter's Laboratory rated for the Class and Division of service required.
- C. Underwriter's Laboratories recognized motor construction and motor-protector combination.
- D. Motors shall be 100% production tested to assure compliance with this Specification.
- E. A factory load test shall be performed on each energy efficient motor to assure compliance with the energy-efficiency section of this Specification. Typical test-data on each motor shall be available if requested.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Motors: General Electric, Gould, Marathon, Reliance, Baldor.
- B. Power factor correction capacitors: Cornell-Dubelier, General Electric, Sprague, Westinghouse, Zucker.

C. ~~Drives: Browning, Woods.~~

D. ELECTRIC MOTORS

E. General:

1. Typically, motor electrical characteristics shall be as follows:
 - a. Smaller than 1/2 HP - 1 phase, 60 hertz.
 - b. 1/2 HP and larger - 3 phase, 60 hertz.
 - c. Refer to equipment schedules on drawings for voltages.
2. Motors are to be started across-the-line unless noted otherwise or as noted below:
 - a. 208/240 volt: part winding start for motors 25 HP and above.
 - b. 480 volt: part winding start for motors 50 HP and above.
3. Unless otherwise noted, two-speed motors shall be double winding.
4. Select motors with low starting current. Design motors for continuous duty to provide the running torque and pull-in torque required to suit the load.
5. Generally, motors are to be drip-proof design with NEMA service factors of at least 1.15. Provide totally enclosed fan cooled (TEFC) or totally enclosed air-over (TEAO, TENV) motors when exposed to the weather or otherwise called for, with 1.0 service factors.
6. Select motors to operate at design conditions without exceeding nameplate ratings using service factor of 1.0.
7. Provide motor nameplates that indicate class of insulation, winding material and service factor in addition to usual electrical data.
8. Provide motor stators made from highgrade steel. Rotors shall be dynamically balanced, die cast aluminum. Winding material shall be copper.
9. Motor frames shall be steel. Motor brackets (ends) shall be steel or cast iron for motor sizes up to and including 50 HP, and cast iron for over 50 HP.
10. Motors shall not be furnished that operate at a higher speed than noted for specific items of equipment. Unless otherwise noted, speed shall be 1750 rpm.
11. Unless otherwise noted, motors shall be suitable for operation in either direction or rotation.
12. Motors shall be designed for mount orientation for which they are used.
13. Motors 1 HP and larger shall be compatible with variable frequency drive systems.

F. Single Phase Fractional Horsepower Motors:

1. Low Starting Torque, Direct Drive Applications:
 - a. Permanent Split Capacitor (PSC) starting. Capacitor wired in series with start-winding and parallel with run winding.
 - b. Sleeve or ball bearing design.
 - c. Provide with automatic overload protection.
2. High Starting Torque Applications:
 - a. Capacitor-start type with starting, pulling and running characteristics to suit the load.
 - b. Prelubricated ball bearing design.

- c. Provide with automatic overload protection, except where automatic restart would endanger personnel or equipment, in which case provide manual reset protector.

G. General Purpose Polyphase Motors:

1. General:
 - a. Frame/horsepower relationships for single speed motors shall be in conformance with NEMA Standard T-Frame sizes.
 - b. Motors utilized with a variable speed drive shall be a NEMA "B" design type.
2. Energy Efficient Motors:
 - a. Motors one (1) horsepower and larger shall be energy efficient type which exceed the Energy Policy Act of 1992, and as defined by the local Utility company, with the following minimum full load efficiencies, based on 1750 RPM open motors and in accordance with the NEMA Nominal Efficiency Rating Procedure:

HP	EFFICIENCY	HP	EFFICIENCY
1	85.5%	25	93.6%
1.5	86.5%	30	94.1%
2	86.5%	40	94.1%
3	89.5%	50	94.5%
5	89.5%	60	95.0%
7.5	91.0%	75	95.0%
10	91.7%	100	95.4%
15	93.0%	125	95.4%
20	93.0%	150	95.8%
 - b. Motors selected at other than 1750 RPM shall be selected from same motor series as required for the 1750 RPM motors.
3. Insulation System:
 - a. Insulation system shall have been tested by the manufacturer and be Class B or Class F except for motors utilized with Variable Speed Drives (VSD's). The manufacturer shall provide Class F insulation for motors connected to VSD's.
 - b. Unless otherwise noted, motors shall be rated for continuous duty, 40° C. ambient operation.
4. Bearings:
 - a. Bearing shall be anti-friction type, rated for minimum B-10 life of 20,000 hours, assuming bearing load to be calculated with a NEMA minimum V-belt pulley located so that centerline of the belt load will be located at end of NEMA standard shaft extension. Bearing housing shall have plugged provision for relubrication on 192T and larger motor frames.
5. Noise Levels:
 - a. Sound power levels shall be no greater than the guidelines recommended by NEMA (MG1-12.49).

2.2 POWER FACTOR CORRECTION

- A. Provide power factor correction capacitors for motors 3 horsepower or larger in accordance with the following requirements. Capacitors shall be selected so that they do not overcorrect the power factor beyond 99.99% throughout the range of operation of the motor. Reference to "full load" means the rated motor horsepower not including the service factor.

1. Variable Air Volume Air Handling Units: Correct fan motors to a minimum 95% power factor when operating at 30% of full load.
2. Variable Speed Pumps: Correct pump motors to a minimum 95% power factor when operating at 30% of full load.
3. Motors with Constant Load: Correct to a minimum 95% power factor when operating at 65% of full load.
4. Two Speed Motors: Correct to a minimum of 95% power factor when operating at 65% of full load at low speed.
5. Direct Expansion Refrigeration Compressors: Correct compressors to a minimum of 95% power factor when operating in its least loaded condition.

Note that in many cases high efficiency motors do not meet the above criteria without correction.

- B. Motors that operate during emergency situations only, such as fire pumps, smoke exhaust fans and stairway pressurization fans, may be excluded from power factor correction. In addition, motors connected to variable speed drives shall be excluded from the power factor correction requirements.
- C. If equipment is furnished with a control panel, that panel shall come with power factor correction capacitors factory installed and wired.
- D. For equipment that does not have a control panel, the equipment supplier shall be responsible for furnishing the capacitors and installing them at either the motor disconnect or motor control center.
- E. Individual capacitors shall be dry electrolytic type and enclosed in integrated dust tight enclosure.
- F. Capacitors shall be wired such that they are energized only when the load to be corrected is operating.

2.3 MOTOR CONTROLLERS

- A. In general, motor controllers will be furnished and installed under Division 16 unless the motor controller is an integral part of a piece of equipment, or noted otherwise.
- B. Where control components are factory furnished, a control transformer with fused secondary shall be provided to reduce voltage to 120 volts to operate control and safety devices.

2.4 BELT DRIVES

- A. V-belt drives for equipment with motors smaller than 3 horsepower shall be rated for 150% of rated horsepower of the driven equipment with matched pulleys and belts. V-belt drives for equipment with motors 3 horsepower and larger shall be rated for 200%.
- B. Variable pitch drives shall be selected so that the fan speed at the specified operating conditions is approximately centered on the sheave adjustment range.
- C. Exposed belt drives shall have OSHA approved guards to completely enclose sheaves and belts. Guards shall be constructed of expanded metal and reinforced with angle iron and

securely fastened to floor or base. Provide openings at motor and driven equipment shafts for taking tachometer readings.

- D. Except as specified otherwise, provide variable sheaves for motors 15 HP and smaller and fixed sheaves for motors 20 HP and larger.
- E. Belt driven equipment shall include an adjustable motor base for adjusting belt tension.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all motors furnished under Division ~~15~~22 and 23, as recommended by manufacturer.
- B. Check rotation of motor driven equipment and lubricate as recommended by manufacturer.
- C. Align all drive systems and adjust belt tension as recommended by manufacturer. Remove pulley set screws, install thread locking substance on threads, and reinstall screws, torquing to manufacturer's specifications.
- D. Check and adjust belt guards so that no parts are in contact with rotating equipment.
- E. After all fan systems have been balanced and the balance report has been submitted and returned by the engineer stamped, "No Exceptions Taken", the contractor shall replace all variable pitch drives with fixed pitch drives to provide the balanced speed of the fan.
- F. The contractor shall make necessary sheave changes to balance the system as per the contract documents at no cost to the Owner.

END OF SECTION

SECTION 23 05 16

HYDRONIC PIPING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Chilled water piping
- B. Hot water heating piping
- C. Underground insulated piping

1.2 QUALITY ASSURANCE

- A. Welding materials and labor shall conform to ASME Code and applicable State labor regulations.
- B. Use welders fully qualified and licensed by State authorities. Welders shall be certified for ASME procedures for high pressure systems where applicable.
- C. The manufacturer's mark or name shall be attached to each length of pipe, fitting, and/or device employed in the piping system.

D. Underground Piping

1. Provide the services of a certified manufacturer's representative to instruct the contractor on the installation procedures of the piping, and to be present on site to assist during critical stages of installation and testing. The representative must be a direct employee of the manufacturer who is certified to provide Field Technical Assistance (FTA).
2. One (1) day of FTA shall be provided for each 500 feet of trench with a minimum of FIVE (5) days required. These FIVE days shall not be consecutive days and must be spread out over the duration of the installation. It is the installing contractors responsibility to schedule these days, with enough advance notice, to facilitate the manufacturer's representative. The FTA representative shall observe critical periods of the installation including the following:
 - a. Initial inspection of the trench and initial pipe placement
 - b. Initial field joint closure instruction and inspection
 - c. Any field modification to the piping system.
 - d. Initial backfill of piping in trench
3. Include a report consisting of the installation log indicating actual installed conditions and test certification signed by the manufacturer's representative above, the contractor, and the Architect's representative. Include certification by the manufacturer's representative that the installation is in conformance with the manufacturer's recommendations.
- 4.4. Pre-insulated pipe manufacturer shall provide testing on the polyurethane foam as indicated within these specifications.

1.3 REFERENCE STANDARDS

- A. ANSI (American National Standards Institute).

- B. ASME (The American Society of Mechanical Engineers).
- C. ASTM (American Society for Testing and Materials).
- D. ASTM B813, Water-flushable lead-free flux
- E. ASTM B32, Lead-free alloy solder
- F. ASTM B828, Procedures for soldered joints

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Grooved piping systems: Tyco-Grinnell, Victaulic or approved equal.
- B. Fiberglass reinforced plastic pipe: Smith Fiberglass Products, Bondstrand or approved equal.
- C. Underground insulated piping: Perma-Pipe/Ric Wil Poly Therm, Urecon₁ or approved equal.

2.2 PIPING AND FITTINGS

- A. Chilled Water, Hot Water Heating:

1. Above Grade:

- a. Black steel, ASTM A-53 Type F or A-53 Type ERW Grade B or A-106 seamless; 10 inch and smaller - Schedule 40; 12 inch and larger - 0.375 inch minimum wall thickness. All sizes with welded and flanged joints.
- b. Option for 2" and smaller: Type "L" hard temper copper tubing with wrought copper fittings, joined with equal to Thermacote Welco 5 solder and flux.
- c. Pipe Fittings for 125 psig Working Pressure:
 - 1) 2-1/2 inch and Smaller: Class 125 cast iron or 300 pound ductile iron, screwed.
 - 2) 2 inch and Smaller: Precision cold drawn austenitic stainless steel, Type 304/304L, complete with synthetic rubber O-rings. (Grade to suit the intended service.)
 - 3) 2-1/2 inch and Larger: Ductile iron, conforming to ASTM A536; forged steel, conforming to ASTM A234; or fabricated from carbon steel pipe, conforming to ASTM A53; with grooved ends conforming to ANSI/AWWA C606.
 - 4) 3 inch and Larger: Welding fittings, ANSI B16.9, with wall thickness and material identical to pipe in which installed. Flanges shall be Class 150, ANSI B16.5, forged steel, screwed, welding neck or slip-on type.
- d. Pipe Fittings for 250 psig Working Pressure:
 - 1) 2-1/2 inch and Smaller: 250 pound cast iron or 300 pound ductile iron, screwed.
 - 2) 3 inch and Larger: Welding fittings, ANSI B16.9, with wall thickness and material identical to pipe in which installed. Flanges shall be Class 300, forged steel, screwed, welding neck or slip-on type, ANSI B16.5.
- e. Mechanical grooved couplings and fittings are acceptable, equal to Tyco-Grinnell Figure 772, 705, 707 or Victaulic Style 07, 75, or 77.
 - 1) Grooved joint fittings shall be manufactured of ductile iron, conforming to ASTM A536; forged steel, conforming to ASTM A234; or fabricated from

carbon steel pipe, conforming to ASTM A53; with grooved ends conforming to ANSI/AWWA C606.

- 2) Grooved joint couplings shall consist of ductile iron housings, conforming to ASTM A536, complete with pressure responsive synthetic rubber gasket. (Grade to suit the intended service.)
 - a) Rigid Type: Coupling housings cast with universal housings shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9. Tyco-Grinnell Figure 772 or Victaulic Style 07.
 - b) Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings shall be placed in close proximity to the vibration source. Tyco-Grinnell Figure 705/707 or Victaulic Style 75/77.
 - c) Flange Adapters: Flat face, for direct connection to ANSI Class 125/150 flanged components. Tyco-Grinnell Figure 71 or Victaulic Style 741.
- f. Gasket material and flange bolting materials shall be suitable for the service and pressure class intended.

B. Underground Insulated Piping:

1. All underground Chilled Water distribution lines, as shown on the contract drawings, shall be factory pre-engineered, pre-fabricated and pre-insulated. All straight sections, fittings, and other accessories shall be factory prefabricated to job dimensions, and designed to minimize the number of field welds. The system design shall be in strict conformance with ANSI B31.1 latest edition, and stamped by a registered professional engineer employed by the pre-insulated piping system manufacturer.
2. Service Pipe shall be Foreign or Domestic Standard Weight, A53, Grade B ERW. All joints shall be butt-welded for sizes 2 ½ inches and greater, and socket welded for 2 inches and below. Where possible, straight sections shall be supplied in 40 foot random lengths with 6 inches of piping exposed at each end for field joint fabrication. 20' Sticks are acceptable on jobs that would increase the freight unnecessarily.
3. Sub-Assemblies, fittings and end seals shall be designed and factory prefabricated onto the longest practical pipe. Field insulation of fittings shall not be allowed.
4. The service pipe insulation shall be polyurethane foam with 2 lb/ft³ minimum density, 90% minimum closed cell content, Insulation Compressive Strength of 40 psi, and maximum initial thermal conductivity of 0.16 Btu-in/hr-ft²-F°. The insulation shall completely fill the annular space between the service pipe and the jacket and shall be bonded to both. Systems using open cell insulation or a nonbonded design shall not be allowed. The polyurethane foam insulation shall be tested by the manufacturer for mechanical and thermal properties to assure compliance with the above values. All test samples will be taken from production material, identified, tagged and tested in accordance with the table below. Test reports showing results will be furnished to the owner and/or engineer for approval. Data supplied by the polyurethane foam chemical supplier is not acceptable.

Attribute	ASTM STD	Sample Frequency	Requirement
Insulation	D 1622	Once per Batch	> 2.0 lb/ft³

Density			
Insulation Compression Strength	D 1621	Once per Batch	> 40 PSI
Insulation Closed Cell Content	D 2856	Once per Batch	> 90%
Insulation Thermal Conductivity	C 518	Once per Batch	< 0.16 BTU- inch/hr/ft²/°F

All insulation shall be provided to a minimum thickness of one & one half (1½) inch

5. The outer protective jacket shall be either fiberglass (FRP) filament wound directly onto the urethane foam insulation or Fiberglass pipe with a minimum wall thickness of .085" with poured or injected urethane insulation systems. Thermoplastic casing material PVC or Polyethylene, shall not be allowed for direct buried piping. All straights and fittings shall be factory pre-insulated and jacketed. Jackets over fittings shall be either chopped spray-up FRP or joined with fiberglass hand layups with thicknesses equal to the thickness of the FRP jacket on the straight lengths. No taping, gluing or shrink wraps shall be allowed on fitting fabrication.

2-6. Pipe, valves, fittings and specialties within vaults are not part of the prefabricated system and shall be furnished uninsulated by the contractor and then field insulated by the insulation subcontractor.

3. Steel Conduit Type:

- a. Equal to Perma-Pipe, Prefabricated underground insulated piping. Conduit shall be 10 gauge smooth wall galvanized steel, Galva-Gard, multiple machine coated with high melting point asphalt with an interposed layer of fiberglass cloth and one (1) final outer wrap of asphalt impregnated fiberglass reinforced asbestos pipe line felt applied spirally under tension. Minimum coating thickness shall be 3/16 inch.
- b. The unloading, handling and installation of the underground insulated piping system shall be in strict accordance with the manufacturer's recommendations. A qualified, factory trained representative of the conduit manufacturer shall be present during all critical periods of the installation indicating that the system was installed in accordance with the manufacturer's recommendations. He shall also provide operating and maintenance instructions to the Owner.
- c. Piping shall be Schedule 40 black steel, ASTM A 53 Type ERW Grade B or A 406 seamless with welded joints. All piping shall be hydrostatically tested in the field under a pressure of 250 psig or twice the working pressure, whichever is greater, and all piping joints shall be hammer tested. Provide fiberglass insulation, [] thick on heating piping and [] thick on chilled water piping.
- d. Conduit connectors shall be minimum 10 gauge and of the welded type. Conduit shall be air tested in the field at 15 psig and all joints shall be soap tested. Air pressure shall be kept in conduit while backfilling is being conducted and until system is completed and turned over to the Owner. After conduit field joints have been soap tested, apply Rip-Coat Mastic Blanket protective coating over the conduit connectors.
- e. Conduit ends shall be provided with end seals or gland seals as required where conduit enters buildings. Conduit seals to have drain and vent openings. Conduit to be vented to atmosphere. The terminal ends of conduits in walls at building shall be equipped with leak plates or wall sleeve leak plates.

- ~~f. Where anchors are required, furnish and install concrete anchor block to be poured around each steel anchor plate and conduit in accordance with the manufacturer's recommendations.~~
 - ~~g. Provide expansion type watershed at each riser and other accessories as shown on drawings and as recommended by the manufacturer.~~
 - ~~h. The supplier of the prefabricated insulated pipe units shall be responsible for providing a design that will accommodate pipe expansion and shop drawings shall be submitted that show all lengths of the piping system and all required components.~~
- ~~4.7. Any pre-insulated piping system shall be provided with requirements as described for Perma-Pipe, including compensation for expansion, watertight joints, shop drawings and field supervision by a factory trained representative.~~

PART 3 - EXECUTION

3.1 SEISMIC RESTRAINT

- A. Fabricate and support piping in accordance with specifications herein, and latest edition of CMC. Provide seismic restraint in accordance with a current OSHPD pre-approved system that carries a current OSHPD OPA Number. For seismic restraint, see Section 23 05 48.
- B. Install seismic separation assemblies at building seismic joints.

3.2 PREPARATION OF PIPING

- A. Ream pipe ends to remove burrs. Make joints smooth and unobstructed inside. Remove any obstructions or debris inside piping, blowing it out with compressed air or otherwise cleaning it internally immediately prior to assembly.
- B. Cap or cover open piping during erection to prevent entry of foreign objects.

3.3 GENERAL

- A. No lead bearing solders shall be used for assembly of piping specified under this Section. Flux shall be water-flushable and lead-free.
- B. Nipples shall be the same material, composition and weight classification as the pipe with which they are installed. Close or running thread nipples shall not be used.
- C. Install horizontal piping parallel with adjacent walls and partitions unless otherwise shown. All risers shall be plumb. Springing or forcing piping into place will not be permitted unless specifically called for.
- D. Take branches and riser arms off the top of mains at a 45 degree angle, unless otherwise shown.
- E. Use a minimum of two field fabricated or installed fittings or joints when connecting piping to equipment or prefabricated piping assemblies.
- F. Grade piping for drainage using 1 inch drop per 40 feet of run, except where otherwise indicated. Hot water heating and chilled water piping shall pitch upward in direction of flow.
- G. Provide manual drain valves at low points and bottom of risers in chilled water and hot water heating piping.

- H. Where air pockets or water traps cannot be avoided, provide means for drainage of low points in water piping, with 3/4 inch drain valve. Provide manual air vents for all air pockets and high points of water piping systems, with 1/2 inch tubing and boiler drain valve installed in accessible location. Where it is necessary or where indicated, provide automatic air vents. Install ball valve shut-off ahead of each automatic air vent that does not contain an integral shutoff valve.
- I. Arrange piping to provide access to coils in piping or ductwork, manholes and access openings, and to permit convenient removal of heads and coils and pulling of tubes. Removal of heads and coils and pulling of tubes shall be accomplished without disturbing equipment shutoff valves and by the removal of a minimum amount of piping between shutoff valves and equipment. Provide additional flanges or unions as required to provide these features.
- J. Run piping to pumps line size as close as possible to pump connections. Pump shut-off valves, check valves, [flexible connections] and strainers shall be line size. Provide eccentric reducer, flat on top, at pump suction to reduce from line size to pump suction connection size, except where suction diffusers are used. Provide concentric increaser at pump discharge to increase from pump discharge connection to line size. Long radius reducing elbows may be substituted for reducers and increasers if radius of turn is in the vertical plane.
- K. Pump seal cavities or pump base plates shall be piped to drain, except when drawings or specifications indicate no drain piping, as for small in-line mounted or floor mounted pumps which have mechanical seals.
- L. All control valves shall be set by this Contractor. Piping to control valves shall be run line size as close as possible to valve connections. Concentric increasers at valve outlets may be used. Use eccentric reducers at valve inlets, flat on top. Strainers shall be line size. Provide unions, grooved joint couplings or flanges at automatic control valves for servicing.
- M. Piping in finished portions of the building, except in mechanical equipment rooms or where otherwise indicated on the drawings, shall be concealed.
- N. Provide clearance for installation of insulation and for access to valves, air vents, drains and unions.
- O. Install same type underground piping material specified for inside building to 5 feet outside of building.
- P. Do not install piping within 3 feet in horizontal direction from electrical panels or equipment. Coordinate with Division 246 contractor.

3.4 WELDED CONNECTIONS

- A. All welding shall be done in accordance with Chapter V of the American Standard Code for Pressure Piping, ASA B31.3 (as amended to date) unless otherwise noted.
- B. Make welded joints with continuous welds, without backing rings, and with pipe ends beveled before welding. Gas cuts shall be true and free from burned metal. Before welding, welding surfaces shall be thoroughly cleaned. Piping shall be carefully aligned and no weld metal shall project inside the pipe.

- C. Use seamless butt-welding fittings at all elbows, tees and reducers. Mitered or fabricated elbows will not be permitted. Gaskets shall be molded and produced by the grooved coupling manufacturer.
- D. Branch lines at least two pipe sizes smaller than the main may be connected by means of 3000 psig forged steel couplings or "Threadolets" in lieu of welding tees.
- E. Where branch lines are at least two pipe sizes smaller than the main and the main is larger than 3", direct welding to the main may be permitted using a "Threadolet". The welder shall demonstrate to the Owner and/or Engineer, acceptable workmanship with this procedure, including proper matching of branch pipe ends to wall contour of the main.

3.5 GROOVED CONNECTIONS

- A. Couplings, fittings, valves and pipe shall be assembled in accordance with the latest published instructions of the manufacturer and local codes.
- B. Pipe shall be checked to be certain that it is free of indentations, projections, grooves, weld seams or roll marks on the exterior of the pipe over the entire gasket seating area to assure a leak-tight seal. Pipe ends must be square cut and in accordance with the manufacturer's standards.
- C. Gaskets shall be of the central cavity pressure responsive design. Gasket style and grade shall be checked to be certain that the gasket supplied is suited for the intended service. Visual inspection of the gasket is required to ensure proper gasket seating.
- D. Thorough lubrication of the gasket exterior including the lips and pipe ends and housing exterior is essential to prevent pinching of the gasket. Lubricants shall be of type recommended by the gasket manufacturer for the intended use.
- E. All grooved couplings, fittings, valves and specialties shall be the products of a single manufacturer. Grooved products shall carry a ten year limited warranty provided by the manufacturer.
- F. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products.
- G. Factory trained representative shall periodically inspect the product installation. Contractor shall remove and replace any improperly installed products.

3.6 MECHANICALLY FORMED TEE CONNECTIONS

- A. Mechanically extracted collars shall be formed in a continuous operation consisting of drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the tube wall. The collaring device shall be fully adjustable as to insure proper tolerance and complete uniformity of the joint.
- B. The branch shall be notched to conform with the inner curve of the run tube and dimpled to insure penetration of the branch tube into the collar is of sufficient depth for brazing and that the branch tube does not obstruct the flow in the main line tube.
- C. All joints shall be brazed in accordance with the Copper Development Association Copper Tube Handbook using B-cup series filler metal. Soft soldered joints will not be permitted.

- D. Mechanically formed branch collars shall be listed by National Standard Plumbing Code, BOCA, IAMPO, SBCC, HUD, U.S. Army Corps of Engineers, Underwriters Laboratory, and shall be acceptable to governing authorities.

3.7 TESTING OF HEATING WATER, CHILLED WATER SYSTEMS

- A. Test these systems under a hydrostatic pressure of 100 psig or 1-1/2 times normal operating pressure, whichever is greater, for a period of 4 hours.
- B. Apply tests to all piping and equipment that is part of these systems, including tanks, pumps, and valves, except items that might be damaged because of excessive pressures.
- C. Start heating and cooling systems, following a procedure that will remove all air from the piping systems.

3.8 CLEANING OF HEATING WATER, CHILLED WATER PIPING

- A. After all equipment and piping has been installed, clean piping systems as follows:
 - 1. Circulate a solution containing 1 pound of trisodium phosphate per 50 gallons of water for 24 hours, at maximum temperature for each system. Operate all system pumps for a minimum of 50% of the cleaning time.
 - 2. Drain system and thoroughly flush with water.
 - 3. Fill, operate and drain system repeatedly until clean. Remove mesh elements of strainers at pumps, control valves and elsewhere and clean or replace repeatedly until system can operate continuously with no buildup of dirt on strainer mesh elements.
 - 4. After pipe cleaning is completed, flush and inspect all mechanical seals and pump impellers for wear and/or damage and replace same with new parts, if defective.

3.9 CORROSION PROTECTION FOR UNDERGROUND PIPING

- A. After testing of underground piping, apply one heavy coat of coal tar bituminous material, equal to Bitumastic 50, to stainless steel, aluminum, cadmium plated or galvanized steel bolts, rods, banding and other items constructed of these materials.

3.10 EXPANSION OF PIPING

- A. Provide expansion loops where shown on drawings or required to prevent damage to piping and equipment due to thermal expansion in the piping system.
- B. Where loops are shown, the height and width dimensions shall be adhered to where possible. If adjustments are necessary because of interferences with other work, obtain Engineer's approval before proceeding with fabrication of the loop.
- C. Expansion loops shall be all welded steel construction, utilizing long radius elbows.
- D. Use flexible type grooved mechanical couplings on expansion loops, in accordance with the latest Victaulic recommendations for expansion joints.
- E. Install loops with "cold spring" so that loop will have 1/2 of the calculated expansion during normal operation.
- F. Anchor pipe in an approved manner at points shown on drawings, using U-bolt or iron bar clamps secured to the building construction.

- G. Install guides to maintain the position and alignment of piping.
- H. Install runouts from mains and/or risers with swing joints of sufficient length to absorb vertical expansion or contraction of risers and horizontal expansion or contraction of mains.
- I. Where space does not permit installation of expansion loops, provide expansion joints as described in Section 23 05 19, Hydronic Specialties.
- J. Install piping to allow for expansion and contraction without stressing pipe, joints, equipment or fixtures.
- K. Install piping connected to equipment to provide flexibility for thermal stresses and for vibration. Adequately support and anchor pipe so that strain from weight and thermal movement of piping is not imposed on the equipment.
- L. Provide piping passing through seismic, expansion, and construction joints with minimum 9 inch deflection capabilities in all directions. Anchor piping on both sides of joint so that building movement will not cause structural stress on piping supports. Use multiple flexible pipe connectors or seismic separation assemblies to achieve deflection capabilities indicated.

3.11 EXCAVATION AND BACKFILL

- A. Perform all necessary excavation and backfill required for the installation of mechanical work in accord with Division 2. Repair pipelines and other work damaged during excavation and backfilling.
- B. All piping shall be fully bedded on sand. Place a minimum 4-inch deep layer on the leveled trench bottom for this purpose.
- C. The trench shall be evenly backfilled with similar materials as the bedding in 6 inch compacted layers to a minimum height of 6 inches above the top of the insulated piping system. The remaining trench shall be evenly and continuously backfilled in uniform layers with suitable excavated soil as required by the contract documents. Earth backfill shall be free of rocks over 2" in diameter and foreign matter. Disposal of excess materials as directed.
- D. The installing contractor shall handle the system in accordance with the directions furnished by the manufacturer and as approved by the architect and engineer. The steel casings shall be air tested at 15 psig and the service piping shall be hydrostatically hammer tested to 150 psig or 1 1/2 times the operating pressure, or as specified in the contract documents. The test pressure shall be held for not less than one hour.

3.12 UNDERGROUND PIPING INSTALLATION

- A. Slope all piping as to vent and drain to building or Vaults.
- B. Utility Marking Tape shall be installed over the entire length of the underground piping. Install plastic detector tape above each pipe at the elevation of approximately 12 inches above the top of pipe line.
- ~~L.C.~~ All underground piping systems must be inspected by the Owner's representative prior to backfilling.

END OF SECTION

SECTION 23 05 19
HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Air elimination valves
- B. Air separators
- C. Automatic air vents
- D. Combination check, balancing, and shut-off valves
- E. Combination pump inlet and strainer fitting
- F. Escutcheons
- G. Expansion tanks
- H. Flow fittings
- I. Flow switches
- J. Manual air vents
- K. Relief valves
- L. Solenoid valves
- M. Strainers
- N. Unions and flanges
- O. Water detection
- P. Self-contained control valves
- Q. Flexible pipe/pump connectors
- R. Flexible expansion loops
- S. Expansion joints
- T. Pipe alignment guides

1.2 REFERENCE STANDARDS

- A. AGA (American Gas Association).
- B. ASME (The American Society of Mechanical Engineers).

1.3 SUBMITTALS

- A. Submit shop drawings on all equipment provided under this section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Air separators: Bell & Gossett, Taco, Thrush/Amtrol, Armstrong, John Wood or approved equal.
- B. Automatic air vents: Thrush/Amtrol, Braukmann, Armstrong, Taco, Hoffman Specialty, Bell & Gossett or approved equal.
- C. Combination check, balancing, and shut-off valves: Bell & Gossett, Mueller, Taco, Armstrong, Victaulic or approved equal.
- D. Combination pump inlet and strainer fitting: Bell & Gossett, Mueller, Taco, Thrush/Amtrol, Armstrong, Victaulic or approved equal.
- E. Escutcheons: Bridgeport, Dearborn Brass, Grinnell or approved equal.
- F. Expansion tanks: Bell & Gossett, Taco, Thrush/Amtrol, Armstrong, John Wood, Wessels or approved equal.
- G. Flow fittings: Gerand Engineering, Bell & Gossett, Hyspan (Barco), Nibco/Hattersley, Presco, Victaulic/T&A, Flow Design Inc. or approved equal.
- H. Flow switches: McDonnell and Miller or approved equal.
- I. Relief valves: Bell & Gossett, Watts, Wilkins or approved equal.
- J. Solenoid valves: Automatic Switch Company, ITT General Controls.
- K. Strainers: Armstrong, Victaulic, Dunham-Bush, Hayward, Metra-Flex, Mueller, Sarco, Watts, Hoffman Specialty or approved equal.
- L. Unions, Dielectric: EPCO or approved equal.
- M. Self-contained control valves: DanFoss, Honeywell-Braukman, Taco, Tour & Anderson.
- N. Flexible connectors: Hyspan, Mason Industries, Metra-Flex or approved equal.
- O. Flexible expansion loops: Mason Industries, Metra-Flex or approved equal.
- P. Expansion joints: Hyspan, Mason Industries, Metra-Flex or approved equal.
- Q. Pipe alignment guides: Hyspan or approved equal.

2.2 AUTOMATIC AIR VENTS

- A. Equal to Thrush/Amtrol automatic air eliminators, float type, pilot operated.

2.3 AIR SEPARATORS

- A. Equal to Bell & Gossett Roll-Airtrol, with strainer, of sizes as shown on drawings.

2.4 COMBINATION CHECK, BALANCING, AND SHUT-OFF VALVES

- A. Equal to Bell & Gossett "Triple Duty" valve designed to act as non-slam check valve, throttling valve, shut off valve, and calibrated flow measurement device. Valves shall seal tightly for positive shut-off.

- B. Valves 1-1/2 inch and smaller shall have threaded connections. Valves 2 inches and larger shall have 125 psig flanged connections.
- C. Valves rated for a maximum working pressure of 175 psig at 250° F. Valves shall be fitted with EPDM seat, replaceable bronze disc, stainless steel stem on valves 2 inches and over, brass stem on valves under 2 inches, and chatter-preventing spring. The valve shall be capable of being repacked under full operating pressure.
- D. Each valve shall be equipped with connections for a portable flow meter.
- E. Grooved End Triple Service Valve Assembly: 300 psig CWP maximum working pressure, consisting of a ductile iron body butterfly valve with elastomer encapsulated ductile iron disc and memory stop feature, and a ductile iron body, non-slam check valve with venturi like taps, assembled with couplings of the same manufacturer (style to be determined by system requirements).

2.5 COMBINATION PUMP INLET AND STRAINER FITTING

- A. Angle type suction diffuser with flanged cast iron or grooved ductile iron body, stainless steel or cast iron vanes and removable brass or stainless steel strainer.
- B. Provide on suction side of base mounted pumps.
- C. In lieu of a suction diffuser, a strainer and a straight section of pipe may be provided at the pump suction. The straight pipe shall have a minimum length of five pipe diameters.

2.6 ESCUTCHEONS

- A. Solid or split style escutcheon flanges and plates shall be chrome plated and sized to fit snugly ~~around~~ tightly around the pipe and conceal the floor or wall opening.
- B. Provide deep pattern escutcheons where required.

2.7 EXPANSION TANKS

- A. ASME constructed and labeled, with gauge glass with isolating valves, drain cock and airtrol fitting. Refer to drawings for sizes.
- B. ~~Equal to Thrush/Airtrol diaphragm~~ Diaphragm type pre-pressurized expansion tanks welded steel construction, tested and stamped by ASME for working pressure of 125 psig and pre-charged to the minimum operating pressure. Refer to drawings for size of tanks. Diaphragm shall be field replaceable.

2.8 FLOW FITTINGS

- A. ~~Equal to Gerand Engineering Company, venturis and indicators, together with balancing valve, where shown.~~ Units shall be complete with meter fittings and metal identification tags. Install Balvalve-Indicators for flows less than 7 gpm, consisting of ball valve with locking device, calibrated orifice with disconnects and metal tag. Install venturis where flow is greater than 7 gpm, screwed ends for sizes 2 inch and smaller and butt weld or grooved ends for 2-1/2 inches and larger. Fasten a chained metal tag to each flow fitting showing location, size, gpm and meter reading for gpm specified. Sizes shall be at mid-scale reading.
- B. Furnish a portable ~~[0 - 50] [0 - 100]~~ inch differential pressure meter for balancing. Meter shall be ~~equal to Gerand Engineering Company, Model [M-50] [M-100],~~ complete with 6 inch dial, steel case, 10 foot meter hoses with disconnect ends, purge valves, blowdown hoses and operating instruction sheet. Meter assembly shall be rated for 250 psig and 250°F.

2.9 FLOW SWITCHES

- A. ~~Equal to McDonnell and Miller Model FS4-3,~~ Underwriter's Listed, rated for 150 psig and 300°F. ~~[one] [two],~~ single-pole double-throw switches, brass and monel wetted parts, adjustable to individual flow requirements.

2.10 MANUAL AIR VENTS

- A. 1/4 inch ball valves complying with Section 23 05 23 Valves.

2.11 RELIEF VALVES

- A. Combination Pressure-Temperature Valves: Equal to Watts Type 40 or larger as required, ASME tested and rated, with test lever and extension thermostat, temperature relief at 210°F. and pressure relief at 125 psig, unless noted otherwise.
- B. Pressure Relief Valves: Equal to Watts Type 174A or 740, ASME rated, with test lever, bronze bodies, selected for a relief pressure applicable with the installation.

2.12 SOLENOID VALVES

- A. ~~Equal to ASCO Series 8240.~~ Unless noted otherwise, solenoid valves shall be direct acting, two-way, manual operators, normally closed, with general purpose solenoid enclosure and stainless steel internal parts.

2.13 STRAINERS

- A. Strainers shall be Y-pattern type, cast iron, ductile iron, or semi-steel (bronze when installed on copper or brass pipe), pressure rated for intended service. Strainers shall have removable stainless steel screen and gasketed machined flanged cap or coupled covers. Strainers shall be screwed for sizes 2 inch and smaller and grooved or flanged for 2-1/2 inch and larger. Strainers to have a minimum effective straining ratio of 3 to 1.
- B. Screens in strainers serving chilled water cooling and hot water heating systems shall have openings 1/8 inch diameter.
- C. Screens in strainers serving condenser water systems shall have openings 3/16 inch diameter.
- D. Strainers shall have a threaded blowdown opening, with full size nipple, ball valve and cap.

2.14 UNIONS AND FLANGES

- A. For systems with pressures less than 150 psig, use 150 pound malleable iron ground joint unions, ANSI B16.39, in steel piping 2 inch and smaller. For the same piping 2-1/2 inch and larger, use cast iron flanges, Class 125.
- B. For systems with pressures 150 - 300 psig, use 300 pound malleable iron ground joint unions in steel piping 2 inch and smaller. For same piping 2-1/2 inch and larger, use cast iron flanges, Class 250.
- C. Where grooved joint systems are utilized, unions are not required. Grooved joint couplings shall serve as unions.
- D. Provide gaskets and bolts for flanges, as required for the temperature and pressure of the piping system.

E. Dielectric Connections:

1. Equal to EPCO, forged steel couplings or unions, rated for 250 psig and 210° F., with all meeting surfaces isolated by gasketing.
2. Equal to Victaulic, carbon steel or ductile iron zinc electroplated waterways, rated for 300 psig and 230°F, with LTHS high temperature stabilized polyolefin polymer liner.

2.15 FLEXIBLE CONNECTORS

- A. Provide flexible piping connectors at the following locations or where indicated on drawings.
1. Vibration isolation.
 2. Misalignment compensation.
- B. For steel piping application use Hyspan Series 4500 with an inner hose of annular corrugated stainless steel, an exterior sleeve of braided stainless steel, a pressure rating of 150 pounds per square inch gauge, joints for 2 inch diameter and larger shall be flanged and for smaller than 2-inch diameter shall be threaded with unions. Size shall be same size as piping connected to.
- C. For copper piping application use Hyspan Series 4500 with an inner hose of bronze, an exterior sleeve of braided bronze, a pressure rating of 150 pounds per square inch gauge, joints shall be threaded with unions or soldered as specified for pipe joints. Size shall be same size as piping connected to.

2.16 FLEXIBLE EXPANSION LOOPS

- A. Provide flexible piping connectors at the following locations or where indicated on drawings.
1. Seismic joint.
 2. Building expansion joint.
 3. Building construction joint.
- B. Expansion joints shall be of the braided stainless steel type. Joints to consist of two flexible sections of hose and braid, two 30° elbows, and a 60° return. Flexible hose section to be stainless steel, close pitch, annular corrugated hose with a braided outer covering of stainless steel. End connections to match mating piping. The overall length shall allow for a minimum of ±4" movement in any direction. Expansion joints shall be equal to Mason Industries model "VFL" for flanged, "VCPS" for copper, "VMN" for male thread, "VGN" for grooved.

2.17 FLEXIBLE PUMP CONNECTORS – BELLOWS TYPE

- A. Provide flexible pump connectors at all pumps or where indicated on drawings, equal to Hyspan Series 5500. Units to include three (3) restraining rods; laminated (Multi-Ply) 321 stainless steel bellows; stainless steel liners; continuous stainless steel surface with 150 pound carbon steel plate flanges (minimum 3/4 inch thickness); chatterproof tie rod spacers.

2.18 EXPANSION JOINTS

- A. For steel piping 3 inch and smaller, provide stainless steel bellows type expansion joints at locations indicated on drawings. Units to be Hyspan Series 1500 or equal with a pressure rating of 150 pounds per square inch gauge and 750 degrees F., maximum compression as indicated on drawing schedule, joint as specified for pipe joints, size shall be same size as piping.

- B. For steel piping larger than 3 inch, provide externally pressurized guided stainless steel bellows type expansion joints at locations indicated on drawings. Units to be Hyspan Series 3500 or equal with a pressure rating of 300 pounds per square inch gauge and 750 degrees F., maximum compression as indicated on drawing schedule, flanged joints, size shall be same size as piping.
- C. For copper or steel piping 4 inches and smaller located above ceilings, provide expansion joints with 2-ply bronze bellows. Units to be Hyspan Series 8500 or equal. Units shall be totally enclosed, externally pressurized bellows protected by wall shroud and isolated from flow impediment by internal sleeve; packless all welded and silicon brazed construction; internal guide ring; integral guides; externally pressurized 2-ply bellows (brazed construction for copper pipe units).
 - 1. Rated working pressure for copper piping 100 pounds per square inch gauge 500 degrees F and for steel piping 175 pounds per square inch gauge 750 degrees.
 - 2. Joints to be soldered or threaded up to 2 inch, flanged over 2 inch and size shall be same size as piping.

2.19 PIPE ALIGNMENT GUIDES

- A. Provide pipe alignment guides equal to Hyspan Series 9500. Guides to be pressed steel joined together by fusion welding with a protective black lacquer paint finish.

PART 3 - EXECUTION

3.1 INSTALLATION OF SPECIALTY DEVICES

- A. Install items in accordance with manufacturer's recommendations.

3.2 AUTOMATIC AIR VENTS

- A. Install automatic air vents where necessary for proper venting of the system, in piping to diaphragm expansion tanks, or where shown on drawings. Pipe discharge to floor drain.

3.3 ESCUTCHEONS

- A. Provide escutcheons in finished rooms where piping penetrates walls, floors or ceilings.

3.4 FLOW SWITCHES

- A. Install flow switches upright in horizontal run of piping and at least five pipe diameters from any valves, elbows, or other restrictions.

3.5 MANUAL AIR VENTS

- A. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- B. Where necessary, extend 1/8 inch copper tubing from the air chamber to an accessible location, terminating with a ball valve.
- C. On pipes 2 inch and larger, use 1/4 inch ball valve, as specified in Section 23 05 23, for manual air vents.

3.6 RELIEF VALVES

- A. Extend full size piping from discharge opening of relief valve to a point 12 inches above the floor. Run discharge to a floor drain if there is one within 20 feet of the relief valve.

3.7 SOLENOID VALVES

- A. Provide a strainer and ball valve ahead of each solenoid valve. Install shock absorber in piping containing solenoid valve.

3.8 STRAINERS

- A. Provide strainers ahead of temperature control valves, steam traps, pumps and elsewhere as shown on drawings or otherwise noted.

3.9 UNIONS AND FLANGES

- A. Provide flanged, grooved joint couplings or screwed unions in connections to equipment and where shown on drawings.

3.10 FLEXIBLE CONNECTORS

- A. Provide flexible pipe connectors on pipes connected to vibration isolated equipment including pumps and where shown. Do not allow weight of piping to be carried by the pump connector.
- B. Install devices in accordance with manufacturer's recommendations.

3.11 FLEXIBLE EXPANSION LOOPS

- A. Provide piping passing through seismic, expansion, and construction joints. Anchor piping on both sides of joint so that building movement will not cause structural stress on piping supports.
- B. Install devices in accordance with manufacturer's recommendations.

3.12 EXPANSION JOINTS AND COMPENSATORS

- A. Install devices in accordance with manufacturer's recommendations.

3.13 PIPE ALIGNMENT GUIDES

- A. Install guides as shown on drawings and where recommended by expansion joint manufacturer.
- B. Rigidly anchor pipe to building structure where necessary. Provide pipe guides so that movement takes place along axis of pipe only.

END OF SECTION

SECTION 23 05 23

VALVES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Furnish and install valves shown on drawings and specified for the isolation or servicing of mechanical systems and equipment.
- B. Install valves furnished with equipment specified under other sections of the specifications.
- C. Coordinate the actuator installation and hookup of any motorized valves with the Temperature Control Contractor or Division 46-26 contractor as required for a complete and functioning system.

1.2 VALVES INCLUDED

- A. Ball valves
- B. Butterfly valves
- C. Check valves
- D. Drain valves
- E. Gate valves
- F. Globe valves
- G. Plug valves
- K. Test Plugs

~~1.3 PROPOSAL: The supplier shall submit a list of exceptions to the contract specifications with his proposal.~~

~~1.4~~1.3 SUBMITTALS

- A. Submit shop drawings for all valves. Refer to Section 23 05 00 for shop drawing preparation requirements.
- B. Provide complete parts list for all valves in Operation and Maintenance Manuals. Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Ball Valves: Apollo, Hammond, Jamesbury, Milwaukee, Tyco-Grinnell, Victaulic, Watts, W-K-M.
- B. Ball Valves (plastic): Chemtrol, Fischer George (FG), GSR, Hayward.

- C. Butterfly Valves: Centerline, DeZurik, Grinnell, Jamesbury, Mueller, Nibco, Tyco-Grinnell, Victaulic.
- D. Butterfly Valves (plastic): Fischer George (FG), Chemtrol or approved equal.
- E. Check Valves: Apollo, Clow, Hammond, Metraflex, Pokorney, Stockham, Technocheck, TRW-Mission, Tyco-Grinnell, Victaulic, Nibco, Milwaukee, Mueller.
- F. Drain Valves: Apollo, Chicago Faucet, Hammond, Watts, Nibco.
- G. Gate Valves: Stockham, Crane, Grinnell, Hammond, Powell, Nibco, Milwaukee.
- H. Globe Valves: Stockham, Crane, Grinnell, Hammond, Nibco, Powell, Milwaukee.
- I. Automatic Flow Control Devices Assemblies: Flow Design, Griswold or Approved Equal.
- L. Test Plugs: Peterson Engineering, Trefice or Approved Equal.

2.2 GENERAL

- A. Manufacturer's name and model, figure or drawing numbers as specified are for identification of type, quality and construction.
- B. Provide valves of same manufacturer throughout where possible.
- C. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.
- D. Ball valves shall be constructed to permit repacking without removal of the valve body from the line and stem shall not blow out under pressure. Valves used for chilled water; heating hot water; and domestic tempered, hot, and cold water service shall be insulated as detailed on the drawings.
- E. 2-1/2 inch through 4 inch butterfly valves shall have lever infinite position (throttling) type operators with memory stop and position lock. Valves 6" and larger shall have enclosed self-locking, waterproof, factory lubricated worm gear operators with built-in adjustable mechanical memory stop position with lock and position indicator. Provide chain operators with chain cleats for all valves more than 7'-0" above the floor (hereinafter specified). Manufacturer shall certify compliance with bubble tight shutoff requirements at a differential pressure of not less than 200 psi and temperature specified with the downstream flange removed with flow in either direction. In addition, valves used for balancing shall be provided with adjustable stops and certified suitable for continuous throttling service. Butterfly valves installed in horizontal piping shall be mounted with the stem in the horizontal position and rotation so that the bottom of the dish lifts in the direction of flow.
- F. Valves shall be for not less than 150 psig water working pressure, and in any event shall be compatible in working pressure to the pipe and fittings to which they are attached. Valves shall be designed for the service for which they are installed with all components suitable for operation with the fluid flowing in the system.
- G. Gate valves shall be used for on-off service only.
- H. Except as otherwise specified or shown on plans, valves 2-1/2 inch and smaller shall have screwed end connections and valves 3 inch and larger shall have flange end construction.
- I. All valves utilized for fuel oil or gas service shall be U.L. listed for that service.

2.3 PLUMBING, CHILLED WATER, HOT WATER HEATING)

- A. Ball Valves - 2-1/2 inches and Smaller: Equal to "Apollo-3" Series 82-100, Threaded 3-piece full-port ball valve with 600 psig w.o.g. bronze body, chrome plated ball and blow-out proof stainless steel stem, and reinforced Teflon packing seals, and seats. All balls shall be made solid material and drilled. Valve utilizing hollow balls are not acceptable. Valve shall comply with MSS SP-110. Where valves are used for balancing purposes, provide balancing stops. When valves are installed in insulated piping, provide a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation, provide extended stems of sufficient length to elevate the operator handle and the mechanical memory and position lock device above the insulation. Valves shall be provided by the manufacture cleaned and bagged for Oxygen service.
- B. ~~Ball Valves — 3 inches to 10 inches: Equal to "Apollo" Series 88A-100 Carbon Steel Class 150 standard port valve with ANSI flanged ends. Stainless steel trim. Valve shall comply with MSS SP-85. Where valves are to be installed in insulated piping, provide a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation, provide extended stems of sufficient length to elevate the operator handle, and memory and position locking device above the insulation.~~
- C. Ball Valves - 3 inches and Larger: Equal to W-K-M Dynaseal 310 or Nibco 7515-CS-F-66/75 ball valve with a full bore, carbon steel body; stainless steel ball and stem; and TFE seat. Valves 6 inches and smaller used for shut-off service shall have latch-lock handle and when used for throttling service shall have infinite throttling handle with indicator disc adjustable stop. Valve shall comply with MSS SP-85. Valves 8 inches and larger shall have a worm screw, enclosed operator with positive indicator and, when used for throttling service, an adjustable stop. Where valves are to be installed in insulated piping, provide a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation, provide extended stems of sufficient length to elevate the operator handle, and memory and position locking device above the insulation.
- D. Grooved Ball Valves – 2-1/2 inches through 6 inches: Equal to Tyco-Grinnell Model BV835 or Victaulic Series 726 ball valve with standard bore ductile iron body, chrome plated carbon steel ball and stem; and TFE seat. Valves 6 inches and smaller used for shut-off service shall have latch-lock handle and when used for throttling service shall have infinite throttling handle with indicator disc adjustable stop.
- E. Butterfly Valves - 2 inches and Larger: Nibco - LD2000-3 Butterfly valves shall have drilled and tapped lugs rated for 150 psig positive at minimum temperature of 150oF bubble tight shut off when fully closed. Valves shall have ductile iron bodies with bronze disc, Type 416 stainless steel stem, self-lubricating bushings, and an EPDM seat suitable for at least 250oF. continuous operation with forced hot water. Valves 6 inches and smaller used for shut off service shall have latch-lock handle and, when used for throttling service, an infinite throttling handle with indicator disc adjustable stop. Valves 8 inches and larger shall have worm screw, enclosed operator with positive indicator and, when used for throttling service, an adjustable stop. Where valves are to be installed in insulated piping, provide extended stems of sufficient length to elevate the operator handle, and memory and position locking device above the insulation.
- F. Grooved Butterfly Valves. The operators shall be as specified hereinbefore:
 - 1. Butterfly Valves – 2-1/2 inches to 12 inches: Equal to a Tyco-Grinnell Model B302 or Victaulic Series Vic®-300. Butterfly Valves, 300 PSIG with grooved ends and polyphenylene sulfide (PPS) coated, ductile iron (ASTM A-536) body rated for bubble tight (deadend or bi-directional) service. The disc shall be synthetic rubber encapsulated ductile iron for the intended service. The seats shall be tested to MSDS-

SP-67. Memory stop for throttling, metering or balancing service. Handles available, Gear Operator, 2 Position handle, Chain Wheel option, Locking Device, and Lever Lock handle.

2. Butterfly Valves - 14 inches and Larger: Equal to a Tyco-Grinnell Model B308 or Victaulic Series 709 Butterfly Valve, 175 PSI with grooved ends, a polyphenylene sulfide (PPS) coated ductile iron (ASTM A-536) body, ductile iron disc, and two-piece design 17-4 PH stainless steel stem. The seat and seal material shall be suitable intended service. The valves shall have Type 304 stainless steel disc shoulder and seal retaining screws, reinforced teflon bearings, gear operator, electric or pneumatic. Seat shall be tested in accordance with MSS-SP-67. The valves shall be rated for bubble tight (dead-end or bi-directional) service with memory stop for throttling, metering or balancing service. Handles available, Gear Operator, 2 Position handle, Chain Wheel option, Locking Device, and Lever Lock handle.

~~G.~~ ~~Grooved Check Valves:~~

~~H.G.~~ Check Valves - 2-1/2 inches and Smaller: Equal to Stockham Figure B-319 or Nibco T413B, ANSI Class 125 (rated for a minimum 150 psig w.o.g. at 450°F ~~150°F~~.) bronze, swing check valve with screwed ends and bronze disc.

~~I.H.~~ Check Valves - 3 inches and Larger: Equal to Stockham Figure AG-931 or Nibco F918B, ANSI Class 125 (rated for a minimum 150 psig w.o.g. at 450°F ~~150°F~~.) check valve with a 3 percent nickel cast iron body and disc, a stainless steel seat and pin, and flanged connections.

~~J.I.~~ Non-Slam Check Valves - 2-1/2 inches and Smaller: Equal to Clow Figure 329 or Nibco F918B, ANSI Class 125 (rated for a minimum 150 psig w.o.g. at 450°F ~~150°F~~.) silent check valve with Buna-N inserts.

~~K.J.~~ Non-Slam Check Valves - 3 inches and Larger: Equal to Clow Figure 636 or Nibco W910-W, ANSI Class 125 (rated for a minimum 150 psig w.o.g. at 150°F.) silent check valve with Buna-N inserts.

~~L.K.~~ Gate Valves - 2 inches and Smaller: Equal to Stockham Figure B-109 or Nibco S111 ANSI Class 125 gate valve with bronze body, solid style bronze disc, bronze bonnet, solder end connections and a rising-type stem shall be copper-silicon alloy.

~~M.L.~~ Gate Valves - 2 inches and Smaller: Equal to Stockham Figure B-105 or Nibco T124, ANSI Class 125 (rated for a minimum 150 psig w.o.g. at 450°F ~~150°F~~.) gate valve with bronze body, solid style bronze disc, bronze bonnet, screwed end connection and a rising-type stem of copper-silicon alloy.

~~N.M.~~ Gate Valves - 2-1/2 inches and Larger: Equal to Stockham Figure G-623 or Nibco F617-0, ANSI Class 125 (rated for a minimum 150 psig w.o.g. at 450°F ~~150°F~~.) valve with bronze fittings OS & Y silicon bronze shaft, and flanged end connections. The solid style bronze disc shall be fully guided. The stem shall be steel with OS & Y construction.

~~O.N.~~ Globe Valves - 2 inches and Smaller: Equal to Stockham Figure B-17 or Nibco S211-B, ANSI Class 125 bronze body, bronze disc, bronze bonnet, copper-silicon alloy stem and pound bronze bodied valve with solder end connections. The disc and bonnet shall also be bronze, and the stem shall be copper-silicon alloy.

~~P.O.~~ Globe Valves - 2 inches and Smaller: Equal to Stockham Figure B-16 and B-216 (for angle valves) or Nibco T211B, ANSI Class 125 (rated for a minimum 150 psig w.o.g. at

450°F/150°F.) valve with bronze body, bronze disc, bronze bonnet, copper-silicon alloy stem and screwed end connections.

Q.P. Globe Valves - 2-1/2 inches and Larger: Equal to Stockham Figure D-512-6 and D-515-6 (for angle valves) or Nibco F718 B and 7818B (for angle valves), ANSI Class 150 (rated for a minimum 250 psig w.o.g. at 450°F/150°F.) globe ductile iron bodied valve with a bronze disc, bronze seat, bronze stem, and flanged end connections.

2.4 EMERGENCY EYEWASH AND SHOWERS

A. For water supply to emergency eyewash and showers provide shutoff valve equal to "Apollo" Series 75-100 bronze pad locking ball valve with 600 psig w.o.g. bronze body, chrome plated brass ball and blow-out proof brass stem, and reinforced Teflon (with 15% glass) packing, bearings, and seats. All balls shall be made solid material and drilled. Valves utilizing hollow balls are not acceptable. When the valve is installed in insulated piping, provide extended stems of sufficient length to elevate the operate handle and the mechanical positive lock device above the insulation.

2.5 GAS SERVICE AND COMPRESSED AIR

A. Ball Valves - 2-1/2 inches and Smaller: Equal to "Apollo-3" Series 82-100 or Nibco T0595YUL, 3-piece, full-port ball valve, bronze body, ~~chrome plated~~ [stainless steel] ball and blow-out proof [brass] stem, Teflon seals and seats.

B. ~~Ball Valves - 2 inches and Smaller: Equal to Victaulic Series 569, 3-piece, full port ball valve with 300 psig c.w.p. stainless steel body, ball and stem, blow-out proof and PTFE seats. (Compressed Air only)~~

C. Ball Valves - 3 inches and Larger: Equal to W-K-M Dynaseal 310 or Nibco T0595-CS-R-66, full bore, carbon steel body, stainless steel ball and stem, TFE seat. Valves 6 inches and smaller used for shut-off service shall have latch-lock handle and when used for throttling service shall have infinite throttling handle with indicator disc adjustable stop. Valves 8 inches and larger shall have worm screw enclosed operator with positive indicator.

2.6 LOW PRESSURE STEAM (0 - 15 PSIG), MEDIUM PRESSURE STEAM (15 - 125 PSIG), CONDENSATE RETURN

A. Ball Valves - 2-1/2 inches and Smaller: Equal to "Apollo-3" Series 82-100, 3-piece, full-port ball valve, bronze body, stainless steel ball and blow-out proof stem, Teflon seals and seats and extended stem to accommodate insulation.

B. Ball Valves - 3 inches and Larger: Equal to W-K-M Dynaseal 310, full bore or Nibco F515-CS-F-66/FS carbon steel body, stainless steel ball and stem, TFE seat. Provide worm screw enclosed operator with positive indicator. Provide extended stem to accommodate insulation on insulated piping.

C. Butterfly Valves - 2 inches and Larger: Equal to Centerline LT series or Nibco LD2000-5 butterfly valves with drilled and tapped lugs and rated for 150 psig positive bubble tight shut when fully closed. Valves shall have ductile iron bodies with bronze disc, Type 304 stainless steel shaft, self-lubricating bushings, EDPM seat suitable for at least 250°F. continuous operation with forced hot water. Provide with worm screw enclosed operator with positive indicator. Provide extended stem to accommodate insulation on insulated piping.

D. Check Valves - 2-1/2 inches and Smaller: Equal to Stockham Figure B-319 or Nibco T413B, ANSI Class 125 (150 psig with 125 psig saturated steam) swing check valve with an ASTM B-62 bronze body and seat and screwed connections.

- E. Check Valves - 3 inches and Larger: Equal to Stockham Figure AG-931, 200 cwp (150 psig with 125 psig saturated steam) or Nibco F918B check valve with a 3 percent Nickel cast iron body and disc, a stainless steel seat and pin and flanged connections.
- F. Gate Valves - 2 inches and Smaller: Equal to Stockham Figure B-105 or Nibco T124, ANSI Class 125 ASTM B-62 bronze bodied valve with screwed end connections. The solid style disc and bonnet shall also be bronze, and the rising-type stem shall be copper-silicon alloy.
- G. Gate Valves - 2-1/2 inches and Larger: Equal to Stockham Figure G-623 or Nibco 7617-0, ANSI Class 125 cast iron bodied valve with bronze fittings and flanged end connections. The solid style bronze disc shall be fully guided. The stem shall be steel with OS & Y construction.
- ~~H. Globe Valves - 2 inches and Smaller: Equal to Stockham Figure B-17 or Nibco S211-B, ANSI Class 125 bronze (ASTM B-62) bodied valve with screwed end connections. The disc and bonnet shall also be bronze, and the stem shall be copper-silicon alloy.~~
- ~~I.H. Globe Valves - 2 inches and Smaller: Equal to Stockham Figure B-16 and B-216 (for angle valves) or Nibco T211B and T311Y (for angle valves), ANSI Class 125 bronze (ASTM B-62) bodied valve with screwed end connections. The disc and bonnet shall also be bronze, and the stem shall be copper-silicon alloy.~~
- ~~J.I. Globe Valves - 2-1/2 inches and Larger: Equal to Stockham Figure D-512-6 and D-515-6 (for angle valves) or Nibco F718B and F818B (for angle valves), ANSI Class 150 ductile iron bodied valve with flanged end connections. The disc, seat and stem shall also be bronze (Stockham Trim No. 6).~~

2.7 DEIONIZED OR DISTILLED WATER

- A. Flanges: PVC, flanged, with N.I.P.
- B. Ball Valves - 3/8 inch through 4 inch: Equal to F.G. Type 346 or Nibco F45TB-E, CPVC full port valves with socket weld end connections as required to match the piping system. Provide valves rated for at least 150 psig with 73°F. water and rated for bubble tight shut off for dead end service when fully closed. Provide valves with union connections on both sides to allow in-line valve repair without disturbing piping. Seats shall be Teflon, and O-rings shall be EPDM or Viton.
- C. Ball Check - 2 inches and Smaller: Equal to F.G. Type 360 CPVC, or equal to G. F. Type 361 PVDF or U51BC-E (CPVC) valves with screwed or socket weld end connections. Provide valves rated for at least 150 psig with 73°F. water. Provide valves with union connections on both sides to allow in-line valve repair without disturbing piping. Seals shall be EPDM or Viton.
- D. Ball Check - 2-1/2 inches through 4 inches: Equal to Chemtrol CPVC or Nibco U51BC-E (CPVC) valves with flanged or socket weld end connections. Provide valves rated for at least 150 psig with 73°F. water. Provide valves with union connections on both sides to allow in-line valve repair without disturbing piping. Seals shall be Viton.
- E. Diaphragm Valves - 2 inches and Smaller: Equal to F.G. Type 315 PVDF with plain spigots for heat fusion joining. Provide valves rated for at least 150 psig with 300°F. steam or water. Valve construction shall allow diaphragm replacement without removing the valve or handwheel. Operating mechanisms shall be hermetically sealed and isolated from the water. All assembly bolts shall be 316 stainless steel. Diaphragm shall be PTFE.

2.8 DRAIN VALVES

- A. Piping 2-1/2 inches and Smaller: Equal to Apollo Series 78-100 ball valve, 600 pound, bronze body, chrome plated brass ball and blow-out proof brass stem, reinforced Teflon seals and seats, and 3/4 inch hose thread outlet with cap.
- B. Piping 3 inches and Larger: 2 inch ball valve with capped nipple threaded for 2 inch hose unless specified or noted otherwise. Equal to "Apollo" Series 70-100 or Nibco T580-70 ball valve, 600 pound, bronze body, stainless steel ball and blow-out proof brass stem, reinforced Teflon seals and seats.
- C. Provide vacuum breakers on hose bibbs in potable water systems.

2.9 VALVE OPERATORS: Each 2-1/2 inch or larger main or branch valve installed in any boiler room or equipment room at an elevation of 7'-0" or greater above the floor shall be equipped with the appropriate size Babbitt adjustable sprocket rim with chain guide for chain operation and with metal tags with arrows and appropriate labeling indicating which way the chain moves to "open" or "close" the valve. These valves shall be installed with the handwheel in a vertical plane. The continuous chain in this type of installation shall reach within five feet of floor and be hooked to clips arranged to keep walking aisles clear.

2.10 VALVE CONNECTIONS: Provide valves suitable for connecting to adjoining piping as specified for pipe joints. Unless noted otherwise, use only line sized valves.

2.11 TEST PLUGS

- A. Test ports shall be pressure and temperature test plugs. Plugs shall be self sealing plugs rated for the temperature, pressure and fluid associated with the application and shall be capable of accepting a needle type temperature or pressure probe and reclosing when the probe is removed.
- B. Plugs shall be provided with threaded protective caps.
- C. One temperature and pressure test kit suitable for the plugs used on the job shall be provided to the Owner on all installations where the plugs are used.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Furnish and install valves where required and/or indicated on drawings for the control, operation and maintenance of all mechanical equipment and systems. Valves shall be installed on each side of control valves and at all mechanical apparatus and fixtures to permit maintenance of same without shutting down service of the piping systems in the building.
- B. Install valves with stems upright or horizontal, not inverted.
- C. Install valves in a position to allow full stem movement.
- D. Swing Check Valves: Horizontal position with hinge pin level.
- E. Wafer Check Valves: Horizontal or vertical position, between flanges.
- F. Locate valves for easy access and provide separate support where necessary.

- G. Valves at hot water heating and cooling coil connections shall be 2-piece body ball valve style.
- H. Install manual drain valves at every low point of each water piping system. Exact location of each drain valves shall be submitted to the Engineer for approval.
- I. Provide non-slam check valves in discharge piping of condensate pumps and sump pumps.
- J. Grooved end valves shall be of the same manufacturer as the grooved fittings and couplings and shall carry a ten year limited warranty provided by the manufacturer.

END OF SECTION

SECTION 23 05 48

VIBRATION ISOLATION AND SEISMIC RESTRAINTS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Vibration isolation
- B. Seismic restraints

1.2 PERFORMANCE REQUIREMENTS

- A. Exercise particular attention when providing isolation for equipment that is not loaded uniformly. Consider weight and location of connecting ductwork and piping.
- B. Coordinate work with other trades to avoid contact with installation that would reduce the effectiveness of the system.
- C. Treat isolators that are exposed to weather, with epoxy paint for resistance to corrosion unless otherwise noted.
- D. Mounts shall be selected to perform their function without undue stress or overloading.
- E. Spring isolators shall be of all welded construction. Springs selected with a 50 percent overload safety factor.
- F. Seismic restraining device shall be capable of withstanding horizontal and vertical forces to meet OSHPD requirements. For OSHPD projects the seismic restraining system shall carry a pre-approved number identifying the method has OSHPD pre-approval.
- G. The anchorage and/or seismic restraint of permanent equipment and associated systems listed below shall be designed to resist the total design seismic forces prescribed in Section 1632.2 of the 2007 California Building Code.
- H. Seismic restraints may be omitted from suspended piping, duct, conduit and cable trays listed above if all of the following conditions are satisfied:
 - 1. Lateral motion of the system will not cause damaging impact with surrounding systems or cause loss of system vertical support.
 - 2. System must be welded steel pipe, brazed copper pipe, sheet metal duct, steel conduit or similar ductile material with ductile connections.
 - 3. Rod-hung supports less than 12 inches in length must have top connections to the structure such as swivel joints, eye bolts or vibration isolation hangers for the entire length of the system run.

1.3 QUALITY ASSURANCE

- A. Selection and installation of vibration isolation and seismic restraint devices shall be performed under the direct supervision of the vibration manufacturer's representative.

- B. All vibration isolators shall have verifiable load deflections to allow checking the deflection under load with the rated deflection.
- C. Select isolators in the linear portion of their load versus deflection curve. Curve shall be linear over a deflection range of not less than 50% above the design deflection.
- D. The lateral to vertical stiffness ratio shall not be less than 0.9 nor greater than 1.5.
- E. The theoretical vertical natural frequency for each support point, based on load per isolator and isolator stiffness, shall be within + 10% of the design objectives for the equipment.
- F. All neoprene mountings shall have a shore hardness of 35 to 65 + 5, after a minimum aging of 20 days or corresponding oven aging.
- G. All metal parts of mountings exposed to weather or corrosive environments shall be hot dip galvanized, except springs and hardware. Springs shall be cadmium plated and neoprene coated. Nuts and bolts shall be cadmium plated.
- H. Where possible, all vibration isolation and seismic restraint devices shall be the product of a single manufacturer, except where included as a part of factory assembled equipment.
- I. All anchorages and/or seismic restraints shall be designed by a registered professional structural engineer licensed in the State of California. Design shall include:
 - 1. Number, size and location of anchors for floor or roof-mounted equipment. For curb mounted equipment, provide design of attachment of both the unit to the curb and the curb to the structure. For units weighing greater than 2500 lbs or curbs more than 12 feet long, provide substantiating calculations that show the curb can accept the prescribed seismic forces.
 - 2. Number, size and location of seismic restraint devices and anchors for vibration-isolated and suspended equipment. Provide calculations, test data or California OSHPD approval number verifying the horizontal and vertical ratings of the seismic restraint devices, number, size and location of braces and anchors for suspended piping, ductwork, conduit and cable trays on as-built plan drawings.
 - a. The contractor must select a single seismic restraint system pre-designed to meet the requirements of the 2007 California Building Code. Examples of approved systems are Mason Industries Guide for Seismic Restraint or Tamarco ISAT.
 - b. Details or designs from separate seismic restraint guidelines are not acceptable. Installations not addressed by the selected system must be designed, detailed and submitted along with the as-built plan drawings.
 - 3. Maximum seismic loads shall be indicated on drawings at each brace location. Drawings shall bear the stamp and signature of the registered professional engineer who designed the layout of the seismic braces.

1.4 REFERENCE STANDARDS

- A. ASHRAE – Guide to Average Noise Criteria Curves.
- B. ARI (Air-Conditioning and Refrigeration Institute).
- C. AGMA.

- D. IEEE.
- E. OSHPD pre-approval program

1.5 SUBMITTALS

- A. Submit signed and sealed shop drawings for vibration isolation devices not furnished as a part of factory assembled equipment. Drawings shall include a schedule of the various types of vibration isolation and the equipment where they will be used.
- B. Submit a layout drawing showing how and where the pre-approved anchorage and bracing systems will be applied to each applicable system.
- C. Furnish load versus deflection curves for vibration isolators.
- D. Submit shop drawings and product data for the following:
 - 1. Spring-type Isolators: Include spring diameter, deflections, compressed spring height, and solid spring height.
 - 2. Cable Restraints: Show method of achieving vertical restraint.
- E. Indicate inertia bases on shop drawings.
- F. Indicate vibration isolator locations, with static and dynamic load on each, on shop drawings and described on product data.
- G. Submit manufacturer's installation instructions.
- H. Submit manufacturer's certificate that isolators are properly installed and properly adjusted to meet or exceed specified requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Vibration Isolation: Mason Industries, M.W. Sausse, Amber Booth, California Dynamics, Kinetics Noise Control, Vibration Eliminator Co., Vibration Mountings and Controls or approved equal.
- B. Seismic Restraints: Mason Industries Inc., Tamarco, Tolco Inc. or approved equal.

2.2 GENERAL

- A. Select vibration isolators in accordance with weight distribution of the equipment being isolated to provide reasonably uniform deflection.
- B. Cable assemblies shall have an Anchorage Pre-approval method number from OSHPD in the State of California verifying the maximum certified load ratings.
- C. Mountings and Curbs shall have an Anchorage Pre-approval method number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.
- D. Rod clamp assemblies shall have an Anchorage Pre-approval method number from OSHPD in the State of California.

- E. Seismic solid brace assembly shall have anchorage pre-approval method number from OSHPD in the state of California verifying the maximum certified load ratings.
- F. Clevis cross braces shall have an Anchorage Pre-approval method number from OSHPD in the State of California.
- G. Snubbers shall have an Anchorage Pre-approval method number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.

2.3 ACOUSTICAL PERFORMANCE

- A. Within equipment spaces, the equipment noise levels and noise transmission to adjacent buildings shall comply with all Federal, State and Local Noise Ordinances.
- B. Motors and drives for pumps and refrigeration machines, when installed per the Contract Documents, shall operate with noise levels not exceeding 90 dBA, as determined in accordance with IEEE Standard No. 85 Test "Procedure for Airborne Noise Measurements on Rotating Electric Equipment."

2.4 VIBRATION ISOLATION

- A. Type A1 - Restrained Spring Mount:
 - 1. Spring type isolator equal to Mason Industries Type SLR.
 - 2. Free standing and laterally stable without any housing and complete with 1/4 inch minimum neoprene acoustical friction pads between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load.
 - 3. Provide built-in vertical limit stops with minimum 1/4 inch clearance under normal operation.
 - 4. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
 - 5. Isolator shall be non-resonant with equipment forcing frequencies or support structure natural frequencies.
 - 6. Isolator shall be capable of supporting equipment at a fixed elevation during equipment erection. Installed and operating heights shall be identical.
- B. Type A2 - Housed Restrained Spring Mount:
 - 1. Spring type isolator equal to Mason Industries Type SSLFH.
 - 2. Incorporate seismic restraint in all directions.
- C. Type B1 – Spring Hanger:
 - 1. Vibration hangers equal to Mason Industries Type 30.
 - 2. Hangers shall contain a steel spring located in a neoprene cup manufactured with a grommet to prevent short-circuiting of the hanger rod. The cup shall contain a steel washer designed to distribute the load on the neoprene and prevent extrusion.

3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through 30-degree arc before contacting the hole and short-circuiting the spring.
4. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
5. Where operating weight differs from installed weight, provide built-in adjustable limit stops to prevent equipment rising when weight is removed. Stops shall not be in contact during normal operation.
6. Where hangers must act as rigid connections during installation provide vibration hangers equal to Mason Industries Type PC30, pre-compressed and locked at the rated deflection by means of a resilient seismic up-stop to keep the piping or equipment at a fixed elevation during installation.

D. Type B2 – Spring Hanger in Series with Neoprene Element:

1. Vibration hangers equal to Mason Industries Type 30N.
2. Provide in all critical locations to isolate both sound and vibration.
3. Hangers shall contain a steel spring and neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box.
4. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through 30 degree arc before contacting the hole and short circuiting the spring.
5. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
6. Where operating weight differs from installed weight, provide built-in adjustable limit stops to prevent equipment rising when weight is removed. Stops shall not be in contact during normal operation.
7. Where hangers must act as rigid connections during installation provide vibration hangers equal to Mason Industries Type PC30N, pre-compressed and locked at the rated deflection by means of a resilient seismic up-stop to keep the piping or equipment at a fixed elevation during installation.

E. Type C – Double Deflection Neoprene Mounts:

1. Vibration isolator equal to Mason Industries Type ND or NDR for use with rails.
2. Double deflection neoprene mounting with a minimum static deflection of 0.35 inches.
3. All metal surfaces shall be neoprene coated for corrosion resistance and have friction pads both top and bottom. Provide bolt holes where bolting is required.
4. Neoprene shall be compounded to meet the following criteria:
 - a. Not greater than 70 durometer.
 - b. Minimum tensile strength 2000 psi.

- c. Minimum elongation 300%.
 - d. Maximum compression set at 25% of the original deflection.
- F. Type D - Neoprene Waffle Pads:
 - 1. Neoprene waffle pad equal to Mason Industries Type Super W.
 - 2. Pad type elastomer mounting with a 3/4 inch minimum thickness. Provide 1/16 inch galvanized steel plate between multiple layers of pad thickness.
 - 3. Ribbed or waffle design with suitable bearing plate to distribute load.
 - 4. Maximum loading of 50 psi.
 - 5. Deflection per pad thickness of 0.10 inch.
- G. Type E - Horizontal Thrust Restraints:
 - 1. Horizontal thrust restraint equal to Mason Industries Type WB.
 - 2. Exhaust and supply fans shall be protected against excessive displacement that might result from high air thrust in relation to the equipment weight.
 - 3. Thrust restraints shall have freestanding laterally stable spring elements without any housing in series with 1/4 inch neoprene friction pads between the base and the support.
 - 4. The assembly shall be furnished with one rod and angle stop brackets for attachment to both the equipment and ductwork or equipment and structure.
 - 5. Horizontal restraints shall be attached at the centerline of thrust and symmetrically on either side of the unit.
 - 6. The spring element shall be contained in a steel frame and designed so it can be preset for thrust and adjusted for a maximum of 1/4 inch movement at start and stop.
- H. Type F – Concrete Inertia Base:
 - 1. Concrete inertia base equal to Mason Industries Type K.
 - 2. Rectangular structural beam or channel concrete forms for floating foundations. Bases for split case pumps shall be large enough to provide support for suction and discharge base elbows.
 - 3. Forms shall include minimum concrete reinforcement consisting of half-inch bars or angles welded in place on 6 inch centers running both ways in a layer 1-1/2 inches above the bottom, or additional steel as is required by the structural conditions.
 - 4. Forms shall be furnished with drilled steel members with sleeves welded below the holes to receive equipment anchor bolts where the anchor bolts fall in concrete locations. Height saving brackets shall be employed in all mounting locations to maintain a 1-inch clearance below the base.
 - 5. Base shall be complete with motor slide rails, pump base elbow supports where required, and isolators.

6. Minimum thickness of the inertia base shall be according to the following schedule:

Motor Size (HP)	Minimum Thickness, Inches
5-15	6
20-50	8
60-75	10
100-250	12

I. Type G – Pipe Flexible Connection:

1. Flexible connector equal to Flexonic Series 300 for threaded ends and Flexonics Series 400M for flanged ends.
2. Flexible metal hose, threaded ends, 2 inches and smaller, phosphor bronze, braided, annular corrugations, minimum 10 inches long, rated for 250 psig working pressure and 450° F. operating temperature.
3. Flexible metal hose, flanged ends, 2-1/2 to 8 inches, stainless steel, braided, annular corrugations, minimum 18 inches long, rated for 240 psig working pressure and 1500° F. operating temperature.

J. Type H – Pipe Seals:

1. Piping seals equal to Mason Industries Type SWS or AWS.
2. Where piping passes through equipment room walls or floors, and elsewhere as noted on drawings, provide a split seal to minimize the passage of noise through the seal and vibration to the structure.
3. The seal shall consist of two pipe halves with 3/4 inches or thicker neoprene sponge bonded to the inner faces. The design shall include a bolting arrangement to fix the seal around the pipe and eliminate clearance between the inner sponge face and the piping. Concrete can then be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction or pour of the building member.
4. Seals shall normally project a minimum of 1 inch past either face of the wall and lengths can be manufactured as required. Where temperature exceeds 240° F., 10 pound density fiberglass shall be used in lieu of the sponge, in the same clamping arrangement.

2.5 SEISMIC RESTRAINT

A. Type 1 - Seismic Cable Restraints:

1. Cable assemblies equal to Mason Industries Type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod nut and the clevis or SCBV if clamped to a beam all as manufactured by Mason Industries, Inc.
2. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of 2 and arranged to provide all-directional restraint.
3. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize 2 clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges.

B. Type 2 - Seismic Solid Braces:

1. Solid seismic brace assemblies equal to Mason Industries Type SSB.
2. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint.
3. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize 2 through bolts to provide proper attachment.

C. Type 3 – Rod Clamp:

1. Rod clamp assemblies equal to Mason Industries Type SRC.
2. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of 3 ductile iron clamps at each restraint location when required.
3. Welding of support rods is not acceptable.

D. Type 4 - Pipe Clevis Cross Bolt Braces:

1. Clevis cross braces equal to Mason Industries Type CCB.
2. Pipe clevis cross bolt braces are required in all restraint locations.
3. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt.

E. Type 5 - All-directional Seismic Snubbers:

1. All-directional seismic snubber equal to Mason Industries Type Z-1225.
2. All-directional seismic snubbers shall consist of interlocking steel members restrained by a 1-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4-inch thick.
3. Rated loading shall not exceed 1000 pounds per square inch.
4. A minimum air gap of 1/8-inch shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances.
5. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated.

F. Type 6 - Wedge Anchors:

1. Drill-in stud wedge anchors equal to Hilti Kwik Bolt TZ or approved equal..
2. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is "rolled-up" to create the thread. The stud anchor shall also have a safety shoulder, which fully supports the wedge ring under load.
3. The stud anchors shall have an evaluation report number from the ICC Evaluation Service, Inc. verifying its allowable loads.

G. Type 7 - Female Wedge Anchors:

1. Drill-in female wedge anchors equal to Mason Industries Type SAB.
2. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load.
3. Female wedge anchors shall have an evaluation report number from the ICBO Evaluation Service, Inc. verifying to its allowable loads.

H. Type 8 – All Directional Anchors:

1. All-directional anchors equal to Mason Industries Type ADA.
2. All-directional acoustical pipe anchor, consisting of 2 sizes of steel tubing separated by a minimum 1/2-inch thick, 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction.
3. Allowable loads on the isolation material should not exceed 500 pounds per square inch, and the design shall be balanced for equal resistance in any direction.

I. Type 9 – Pipe Guides:

1. Pipe guides equal to Mason Industries Type VSG.
2. Pipe guides shall consist of a telescopic arrangement of 2 sizes of steel tubing separated by a minimum 1/2-inch thickness of 60-durometer neoprene.
3. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and re-insertable to allow for selection of pipe movement.
4. Guides shall be capable of plus or minus 1-5/8-inch motion, or to meet location requirements.

PART 3 - EXECUTION

3.1 GENERAL

- A. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.
- B. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. No rigid connections that degrade the noise and vibration control system herein specified shall be made between equipment and the building structure.
- D. The contractor shall not install any equipment, piping, duct, or conduit that makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs, and walls.
- E. Coordinate work with other trades to avoid rigid contact with the building.

- F. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the Architect's/Engineer's attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible Contractor's expense.
- G. Install Type 1 cable restraints slightly slack to avoid short circuiting the isolated suspended equipment, piping, or conduit.
- H. Install Type 1 cable assemblies taut on non-isolated systems. Type 2 seismic solid braces may be used in place of cables on rigidly attached systems only.
- I. At locations where Type 1 or 2 restraints are located, the support rods must be braced when necessary to accept compressive loads with Type 8 braces.
- J. At all locations where Type 1 or 2 restraints are attached to pipe clevis, the clevis cross bolt must be reinforced with Type 4 braces.
- K. Drill-in concrete anchors for ceiling and wall installation shall be Type 6 and Type 7 female wedge type for floor mounted equipment.
- L. Vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not permitted on this project.
- M. Air handling equipment and centrifugal fans shall be protected against excessive displacement, which result from high air thrust in relation to the equipment weight. Horizontal thrust restraint shall be Type E.
- N. Locate isolation hangers as near to the overhead support structure as possible.

3.2 VIBRATION ISOLATION OF PIPING

- A. Horizontal Pipe Isolation: The first 3 pipe hangers in the main lines near the mechanical equipment shall be as described in Type B. Type B hangers must also be used in all transverse braced isolated locations. Brace hanger rods with SRC clamps Type 2. Horizontal runs in all other locations throughout the building shall be isolated by hangers as described in Type B2. Floor supported piping shall rest on isolators as described in Type A2. The first 3 isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and is hanging from ceilings under occupied spaces, the first 3 hangers shall have 3/4-inch deflection for pipe sizes up to and including 3-inch; 1-1/2-inch deflection for pipe sizes up to and including 6-inch; and 2-1/2-inch deflection thereafter. Hangers shall be located as close to the overhead structure as practical.
- B. Riser isolation: Risers shall be suspended from Type B2 hangers or supported by Type A2 mountings, anchored with Type 8 anchors, and guided with Type 9 sliding guides. Steel springs shall be a minimum of 3/4-inch except in those expansion locations where additional deflection is required to limit load changes to plus or minus 25 percent of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

3.3 SEISMIC RESTRAINT OF PIPING

- A. Seismically restrain all piping, equipment and ductwork listed as 1, 2, or 3 below. Use Type 1 cables if isolated. Type 1 and 2 restraints may be used on non-isolated piping.
 - 1. Fuel oil piping, gas piping, and compressed air piping that is 1-inch ID or larger.
 - 2. All medical gas piping and vacuum piping.
 - 3. All other piping 2-1/2-inch diameter and larger.
 - 4. Omitted on all piping suspended by individual hangers 12 inches or less in length from the top of the pipe to the bottom of the structural support for the hanger.
 - 5. Pipes, ducts, and conduit supported by a trapeze where none of those elements would individually require bracing need not be braced if connections to the pipe/duct/conduit or directional changes do not restrict movement of the trapeze. If this flexibility is not provided, bracing is required when the combined operating weight of all elements supported by the trapeze is 10 lbs/ft or greater.
- B. Transverse piping restraints shall be at 40-foot maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
- C. Longitudinal restraints shall be at 80-foot maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
- D. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
- E. For fuel oil and all gas piping, transverse restraints must be at 20-foot maximum and longitudinal restraints at 40-foot maximum spacing.
- F. Transverse restraint for 1 pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24 inches of the elbow or TEE or combined stresses are within allowable limits at longer distances.
- G. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
- H. Branch lines may not be used to restrain main lines.
- I. Cast iron pipe of all types, glass pipe and any other pipes joined with a 4 band shield and clamp assembly in Seismic Zones 2B, 3 and 4 shall be braced using type 7.

3.4 VIBRATION ISOLATION OF DUCTWORK

- A. All discharge runs for a distance of 40 feet from the connected equipment shall be isolated from the building structure by means of Type B2 hangers or Type A1 floor isolators. Spring deflection shall be a minimum of 3/4 inch.
- B. All duct runs having air velocity of 1700 feet per minute or more shall be isolated from the building structure by Type B2 hangers or Type A2 floor supports. Spring deflection shall be a minimum of 3/4 inch.

3.5 SEISMIC RESTRAINT OF DUCTWORK

- A. Seismically restrain all duct work with Type 1 or 2 restraints as listed below:
 - 1. Restrain rectangular ducts with cross sectional area of 6 square feet or larger.
 - 2. Restrain round ducts with diameters of 28 inches or larger.
 - 3. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
 - 4. Omitted on all ducts suspended by hangers 12 inches or less in length from the top of the duct to the bottom of the structural support for the hanger, where the hangers are detailed to avoid bending of their hangers and their connections.
 - 5. Pipes, ducts, and conduit supported by a trapeze where none of those elements would individually require bracing need not be braced if connections to the pipe/duct/conduit or directional changes do not restrict movement of the trapeze. If this flexibility is not provided, bracing is required when the combined operating weight of all elements supported by the trapeze is 10 lbs/ft or greater.
- B. Transverse restraints shall occur at 30 foot intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
- C. Longitudinal restraints shall occur at 60-foot intervals with at least 1 restraint per duct run. Transverse restraints for 1 duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 4 feet of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
- D. The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
- E. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
- F. Walls, including gypsum board non-bearing partitions, that have ducts running through them, may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.

3.6 SCHEDULE OF VIBRATION ISOLATION DEVICES

A. Provide equipment isolation and seismic restraint as scheduled below:

Vibration Isolation and/or Seismic Restraint

Equipment Schedule	Type	Static Deflection	Height	Seismic Restraint
Base mounted Packaged air handling units within building	A	2"	6" to 10"	Restrained Spring Mount Seismically bolted down
Roof mounted air handling units	I	3"	14" to 18"	Restrained Spring Mount Seismically bolted down
Base mounted fans	A	1" for less than 400 pounds 2" for greater than 400 pounds	5" to 8"	Restrained Spring Mount Seismically bolted down
Roof mounted fans	A	1" for less than 400 pounds 2" for greater than 400 pounds	5" to 8"	Restrained Spring Mount Seismically bolted down
Suspended Fans under 60 lbs	Use manufacturer provided rubber grommets			Type 1
Suspended fans, air conditioners, heat pumps, air handlers, fan coils less than 400 lbs	B1	2"	4" to 6"	Type 1
Suspended fans, air conditioners, heat pumps, air handlers, fan coils greater than 400 pounds	B2	2"	4" to 6"	Type 1
Base mounted pumps mounted on a slab on grade	D	1/8"		Seismically bolted down
Base mounted pumps mounted on structural floors or roofs	F	2"	8" to 10"	Seismically bolted down
Floor mounted fans	A1 with E thrust restraints	2"		Restrained Spring Mount Seismically bolted down
Roof top cooling towers	A2	2"	10" to 12"	Restrained Spring Mount Seismically bolted down

Rooftop air conditioners, heat pumps 5 tons and less	Use manufacturer provided roof curb with neoprene gasket between the unit and the curb			Curb seismically bolted down
Rooftop air conditioners, heat pumps 6 tons and larger	†	2"	14" to 18"	Curb seismically bolted down
Compressors, vacuum pumps and other reciprocating equipment mounted on slab.	C	1"	3" to 5"	Seismically bolted down

END OF SECTION

SECTION 23 05 53

PAINTING AND IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Paint exposed steel, piping and insulated piping and equipment in mechanical rooms and other similar unfinished spaces as called out in this Section.
- B. Identify piping, equipment and ductwork.
- C. Install marking tape over exterior utilities.

1.2 SUBMITTALS

- A. Provide schedule of paint, colors and numbers if approved manufacturer other than one whose numbers are specified is used.
- B. Provide list of valves to be tagged and identifying description.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Paint: Benjamin Moore, Devoe, Pratt and Lambert, Rust-O-Leum.
- B. Pipe labels: Seton or Brady.
- C. Exterior utilities marking: Allen Systems, Inc., Brady or Seton.

2.2 PAINTING

- A. This Contractor shall be responsible for preparing and painting items described in this section with the exception of priming canvas insulation jacketing, which will be done under the insulation sections of this specification.

2.3 PIPE IDENTIFICATION

- A. Use one of the following systems:
 - 1. Equal to Seton snap-on pipe markers, color coded, as noted, Type SNA markers for pipe sizes 3/4 inch to 5-7/8 inch and Type STR for sizes 6 inch and larger.
 - 2. Equal to Brady pressure sensitive pipe markers, arrows and pipe banding tape, No. B-946 for insulated pipe and No. B-689-~~B-500~~ for uninsulated pipe, color coded as noted.

2.4 DUCT IDENTIFICATION

- A. Label with 1-1/2 inch black stenciled letters.

2.5 CEILING IDENTIFICATION MARKERS

- A. Equal to "Moore" 5/8 inch diameter marking tacks with celluloid covering suitable for ink notation on a colored face.

2.6 VALVE IDENTIFICATION

- A. Tags shall be brass (approximately 19 gauge), 2 inch round minimum, secured with brass "S" hook, chain, or plastic tie wrap.

2.7 EXTERIOR UTILITIES MARKING

- A. Install equal to Allen Systems, Inc. "Markline" marking tape over exterior underground metallic piping, cabling or wiring. Install equal to Allen Systems, Inc. "Detectatape" over exterior underground non-metallic piping.

PART 3 - EXECUTION

3.1 PAINTING

- A. Paint insulation on piping and equipment with latex paint.
- B. Clean oil, rust and/or scale from exposed iron and steel work and paint with Extend-O-Rust neutralizer prior to finish coat of paint.
- C. Omit painting of galvanized or non-ferrous surfaces and factory-painted surfaces.
- D. Touch up factory finishes on exposed items of equipment in finished and unfinished spaces which become chipped or scratched during shipment, installation or during the construction period. Finish color to match factory color.
- E. Provide "Wet Paint" signs as required to protect newly painted finishes. Provide temporary protective wrappings as required to avoid paint spattering on surfaces near work area. Remove those coverings when painting is completed. Upon completion of painting work, clean window glass and other paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

3.2 PIPE AND DUCT IDENTIFICATION

- A. Label piping and ductwork after painting is completed.
- B. At each side of label, tape with directional arrows shall be wrapped entirely around pipe with at least 1 inch overlap or across visible face of duct when standing on floor below.
- C. Label all new ductwork, denoting system number and type (i.e. supply, return, exhaust, etc.) and direction of flow.
- D. Label fire protection system feed mains, standpipe horizontal feed mains and fire department connection feed mains. Fire protection system branch lines and cross mains with branch line connections are not required to be labeled.
- E. Identification shall occur at the following locations:
 - 1. At no more than 15 foot intervals on a straight run of pipe.
 - 2. Wherever a pipe or duct turns 90 degrees or tees.

3. Wherever a pipe or duct passes through a wall, floor, or ceiling, on both sides.
 4. At each branch or riser takeoff.
 5. Adjacent to each valve, device, or fitting.
 6. At other locations, for ease of location and maintenance as directed by the Owner or Architect/Engineer.
- F. Furnish and install the following labels on the appropriate systems. The pipe service description and color schemes noted are intended to be standard manufacturer's labels. In some cases, multiple standard labels or standard and custom labels will be required to be combined to achieve the desired description.

Pipe Service Description	Background	Letters
Condensate Return	Yellow	Black
Hi-Pressure Condensate	Yellow	Black
Lo-Pressure Condensate	Yellow	Black
Lo-Pressure Steam	Yellow	Black
Medium Pressure Steam	Yellow	Black
Hi-Pressure Steam	Yellow	Black
Chilled Water Supply	Green	White
Chilled Water Return	Green	White
Heating Hot Water Supply	Yellow	Black
Heating Hot Water Return	Yellow	Black

- G. Identify all exposed piping and also piping in accessible concealed spaces, such as above lay-in type ceilings, below raised floors and at access panels in non-accessible ceilings and in walls.

3.3 CEILING IDENTIFICATION MARKERS

- A. Provide markers on all removable ceilings and ceiling access panels to indicate locations of valves, dampers, smoke detectors, etc. and other mechanical items that may require servicing or adjustment. Glue marking tacks in place with white glue to prevent their falling out.
- B. Color code markers as follows:
1. Red: Fire dampers, smoke dampers, combination fire and smoke dampers, sprinkler shutoff valves, duct type smoke detectors.
 - a. Notation: D - Damper
V - Valve
S - Smoke Detector
H - Heat Detector
 2. Yellow: Steam, radiation, reheat, chilled water.
 - a. Notation: V - Valve
 3. Gold: Automatic and balancing dampers.
 - a. Notation: V - Valve
D - Damper

3.4 EQUIPMENT IDENTIFICATION

- A. After painting equipment as described above, identify air handling units, separate or remote HVAC coils, fans, pumps and other equipment by stenciling identification on each item; i.e., "AHU No. 1". Coordinate identification with Owner.

3.5 VALVE TAGS

- A. Provide valve tags on all valves, particularly in concealed spaces above ceilings and in pipe chases. Two (2) copies of a typewritten list identifying all numbered valves shall be mounted in plastic containers and submitted to the Owner through the Engineer. Valve tags shall be stamped with identifying description of the valve with lettering as approved by the Owner and Engineer.

3.6 EXTERIOR UTILITIES MARKING

- A. Install marking tape over all exterior underground utilities installed under this Division as a part of this project.

- B. Use the following legends:

CAUTION PIPELINE BURIED BELOW

CAUTION WATER LINE BURIED BELOW

- C. Install the marking tape as close to grade as practical. Allow a minimum of 12 inches between the tape and the line. Increase the tape width as the depth of bury increased in accordance with the following table.

Depth of Bury	Tape Width
0 - 10"	2"
10 - 20"	3"
20 - 25"	6"
25 - 30"	9"
30 - 40"	12"
OVER 40"	18"

- D. ELECTRICAL EQUIPMENT AND CONDUITS

- 1. Paint and label, as described in Section 26 05 53, all electrical equipment and conduits installed as a part of this Division's work.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Perform testing and balancing of the following systems:

1. New and existing air distribution systems.
2. Deionized and distilled water systems.
3. New and existing heating water, condenser water and chilled water systems.
4. New and existing domestic hot water re-circulating system.
5. ~~Smoke evacuation systems.~~
- 6-5. Temperature control systems.
- 7-6. Sound measurement of equipment operating conditions.
- 8-7. Vibration measurement of equipment operating conditions.
- 9-8. Duct leakage testing of new and existing systems.

1.2 QUALITY ASSURANCE

- A. For the heating, chilled water systems and air handling systems, the Contractor shall obtain the services of an independent and certified Testing and Balancing (TAB) Agency for the testing and balancing of air conditioning systems. The agency shall be a fully Certified Member of the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB). The Contractor shall not use his own forces for this work even if they meet the criteria hereinbefore stated.
- B. Personnel performing testing and balancing functions shall be Certified by the AABC or NEBB for those functions.
- C. Perform testing and balancing in complete accordance with AABC Standards for Field Measurement and Instrumentation Form No. 81266 Volume One, as published by the Associated Air Balance Council, or equivalent NEBB Form. Perform testing and balancing on all air and hydronic systems.
- D. Instruments used for testing and balancing of air and hydronic systems must have been calibrated within a period of six months prior to balancing. All final test analysis reports shall include a letter of certification listing instrumentation used and last date of calibration.

1.3 PERFORMANCE REQUIREMENTS

- A. ~~The contractor shall~~ Be responsible for rebalancing entire water and air systems if balance reports are found to be inaccurate by Owner/Engineer.
- B. ~~The contractor shall~~ Select and pay for services of a separate testing agency to perform rebalancing work.
- C. ~~The contractor shall~~ Perform in accordance with commissioning requirements if applicable.

1.4 SUBMITTALS

- A. Submit name of testing, adjusting, and balancing agency for approval within 30 days after award of Contract.
- B. Submit ~~three (3) copies~~ an electronic copy of the complete test reports to the Engineer prior to final acceptance of the project.
- C. Prior to commencing work, submit draft reports indicating adjusting, balancing, and equipment data required.
- D. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.
- E. Provide reports ~~in soft cover, letter size, 3-ring binder manuals,~~ complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations. Identify each outlet and inlet with an identification tag indicating ID No., CFM, neck size and face size.
- F. Include a fan curve for each individual fan plotting actual performance measured versus design performance.
- G. Include detailed procedures, agenda, sample report forms, and copy of AABC National Project Performance Guaranty prior to commencing system balance.

PART 2 - MATERIALS (Not Applicable)

PART 3 - EXECUTION

3.1 GENERAL

- A. Test piping systems after erection and before concealing or covering. Arrange and pay for all tests of mechanical systems as required by code and as herein specified. Replace any materials or workmanship found faulty and retest the system.
- B. Repair any damage resulting from leakage of piping during testing or guarantee periods without any expense to Owner.
- C. Perform tests in the presence of the proper inspectors ~~or~~ and / or an authorized representative of ~~Architect/Engineer~~ the Owner, if required.

- D. With remodeling projects, where it is not possible to isolate new piping for testing, take special care in the installation and in the inspection for leaks after connecting into an existing system. Where it is possible to isolate new piping, perform tests as required by governing codes or requirements hereinafter specified.
- E. Furnish certificates to Architect/Engineer that tests have been satisfactorily completed.

3.2 TESTING AND BALANCING OF AIR AND HYDRONIC SYSTEMS

- A. Verify the completeness and operational readiness of the air distribution systems prior to balancing as follows:
 - 1. Verify installation for conformity to design. All supply, return and exhaust ducts terminated and pressure tested for leakage.
 - 2. All volume and fire dampers properly located and functional. Dampers serving requirements of minimum and maximum outside air, return and relief shall provide tight closure and full opening, smooth and free operation.
 - 3. All systems started up and operating in a safe and normal condition.
 - 4. All supply, return, exhaust and transfer grilles, registers, diffusers, air control valves, and terminal units installed.
 - 5. Air handling systems, units and associated apparatus, such as filter sections, access doors, etc., shall be blanked and/or sealed to eliminate excessive by-pass or leakage of air.
 - 6. All coils are cleaned and combed.
 - 7. All fans (supply, return, and exhaust) operating and verified for freedom from vibration, proper fan rotation and belt tension; heater elements to be of proper size and rating; record motor amperage and voltage and verify they do not exceed nameplate ratings.
- B. Verify the completeness and operational readiness of the water circulating systems prior to balancing as follows:
 - 1. Check and verify pump alignment and rotation.
 - 2. Position all valves pertinent to system design to permit full flow of water through all system components. Operate hydronic systems under full flow conditions until circulating water is clean. All strainers shall be removed and cleaned as required during this cycle of operation.
 - 3. Record each pump motor amperage and voltage. Readings shall not exceed nameplate rating.
 - 4. All water circulating systems shall be full of water and free of air; expansion tanks set for proper water level; all air vents installed at high points of systems and operating freely.
 - 5. Check and set operating temperatures of heat exchangers to design requirements.

- C. Verify the completeness and operational readiness of the automatic controls prior to balancing as follows:
1. Verify that all control components are installed in accordance with project requirements and functional, including all electrical interlocks, damper sequences, firestats and smoke detectors.
 2. All controlling instruments shall be functional and set for designed operating conditions. Factory precalibration of room thermostats, etc., will not be acceptable.
- D. Testing and Balancing of Air Systems:
1. Test and adjust all air systems to the conditions set forth in the Plans and Specifications. The air systems are to include but not be limited to:
 - a. Supply air systems (including stairwell pressurization).
 - b. Return air systems.
 - c. Exhaust and/or relief air systems (including smoke control).
 - d. Minimum and maximum outdoor air systems.
 2. Testing Procedures:
 - a. Air quantity measurements in primary ducts and plenums shall be made by pitot tube traverse of the entire cross sectional area of the ducts.
 - b. Traverse readings shall be taken at the fan discharge main duct and at other key duct locations where major mains separate to serve separate distinct areas of the building such as branch mains to individual floors. Readings shall be taken in the supply, return and exhaust duct mains.
 - c. Outlet and inlet air quantities shall be determined by direct reading velocity meters in accordance with outlet and inlet manufacturer's recommendations. Where flow hoods are utilized to measure outlet air volumes, the summation of all outlet values may be used to represent total fan air volume if the air volume so derived is within 5% of design and can be correlated with fan operating data and a manufacturer's performance curves.
 3. Adjustment Procedures:
 - a. Total system air quantities shall be varied by adjustment of fan speeds or blade pitch.
 - b. Branch duct air quantities shall be adjusted by damper regulation.
 - c. Volume control devices shall be used to regulate air quantities of supply and exhaust air outlets, only to the extent that adjustments do not create objectionable air motion or sound levels in excess of specified limits. Final measurements of air quantities shall be made after supply air outlets have been adjusted to provide the optimum air patterns of diffusion.
 - d. Test and adjust blowers and fans to deliver the cfm required by the systems with concurrent recording of rpm, supply voltage and full load amperes. Report any changes of belts and sheaves required.

- e. Test and adjust all fresh air intake and return air dampers and louvers to the conditions scheduled or required.
- f. Test static pressure on the entering and leaving side of each supply fan, exhaust fan, filter, coil, and other major components of the system.
- g. Test and adjust all supply air diffusers, grilles, return air registers, etc. to the requirements of the Specification and as shown on the Drawings. Adjust supply diffuser pattern blades for proper air distribution in each room or space.
- h. Measure building static pressure and adjust supply, return and exhaust air systems to obtain the required relationship to maintain approximately 0.05 inches w.g. positive static pressure near the building entrance.

E. Testing and Balancing Hydronic Systems:

1. Test and adjust all water systems to the conditions set forth in the Plans and Specifications. The water systems are to include but not be limited to:
 - a. Chilled water system.
 - b. Heating water system.
 - c. Domestic hot water re-circulating system.
2. Adjustment of water distribution systems shall be effected by means of balancing valves and fittings. Service valves shall not be used for balancing unless indexed for balance point.
3. Calibrated venturi tubes, orifices, or other metering fittings and pressure gauges installed in the piping systems, shall be used where provided, in conjunction with the permanent and portable type flow meters, to determine water flow rates for system balance.
4. Systems shall be adjusted to provide the approved pressure drops through the heat transfer elements prior to the thermal testing. A crosscheck of the balancing by measuring differential temperature shall be performed in conjunction with the air balancing.
5. When three-way valves are used, rated pressure drop shall first be adjusted through the heat transfer elements in each of the systems and the temperature differential between inlet and outlet shall be determined to be in accordance with its rating. The by-pass valves shall then be adjusted on each heat transfer element until an equal pressure drop between supply and return connections is obtained with the three-way valves set to by-pass all heat transfer elements in each of the systems.

F. Testing and Adjusting Automatic Controls:

1. Test all automatic controls, controlled devices, interlocks, and safety devices associated with the HVAC system for proper operation and sequence during heating, cooling, intermediate and smoke control modes of operation. Check the adjustment of the automatic controls to deliver the required quantities of air at temperatures specified or scheduled on the Plans and to maintain proper conditions in each room of the building.

G. Marking of Settings:

1. Upon completion of testing and balancing of each system, permanently mark the settings of all major valves, primary dampers, controls, etc.

3.3 TEST DATA

- A. Before final acceptance of the mechanical systems are made, the TAB firm shall furnish the Owner the following data:

~~B. Forms shall include the following information:~~

1. Title Page:
 - a. Company name.
 - b. Company address.
 - c. Company telephone number.
 - d. Project name.
 - e. Project location.
 - f. Project Architect.
 - g. Project Engineer.
 - h. Project Contractor.
 - i. Project altitude.
2. Instrument List:
 - a. Instrument.
 - b. Manufacturer.
 - c. Model.
 - d. Serial number.
 - e. Range.
 - f. Calibration date.
3. Air Moving Equipment:
 - a. Location.
 - b. Manufacturer.
 - c. Model.
 - d. Air flow, specified and actual.
 - e. Return air flow, specified and actual.
 - f. Outside air flow, specified and actual.
 - g. Total static pressure (total external), specified and actual.
 - h. Inlet pressure.
 - i. Discharge pressure.
 - j. Fan RPM.
4. Exhaust Fan Data:
 - a. Location.
 - b. Manufacturer.
 - c. Model.
 - d. Air flow, specified and actual.
 - e. Total static pressure (total external), specified and actual.
 - f. Inlet pressure.
 - g. Discharge pressure.
 - h. Fan RPM.

5. Return Air/Outside Air Data:
 - a. Identification/location.
 - b. Design airflow.
 - c. Actual airflow.
 - d. Design return airflow.
 - e. Actual return airflow.
 - f. Design outside airflow.
 - g. Actual outside airflow.
 - h. Return air temperature.
 - i. Outside air temperature.
 - j. Required mixed air temperature.
 - k. Actual mixed air temperature.
 - l. Design outside/return air ratio.
 - m. Actual outside/return air ratio.
6. Electric Motors:
 - a. Manufacturer.
 - b. HP/BHP.
 - c. Phase, voltage, amperage; nameplate, actual, no load.
 - d. RPM.
 - e. Service factor.
 - f. Starter size, rating, heater elements.
7. V-Belt Drive:
 - a. Identification/location.
 - b. Required driven RPM.
 - c. Driven sheave, diameter and RPM.
 - d. Belt, size and quantity.
 - e. Motor sheave, diameter and RPM.
 - f. Center to center distance, maximum, minimum, and actual.
8. Duct Traverse:
 - a. System zone/branch.
 - b. Duct size.
 - c. Area.
 - d. Design velocity.
 - e. Design airflow.
 - f. Test velocity.
 - g. Test airflow.
 - h. Duct static pressure.
 - i. Air temperature.
 - j. Air correction factor.
9. Air Flow Monitoring Station Data:
 - a. Identification/location.
 - b. System.
 - c. Size.
 - d. Area.
 - e. Design velocity.
 - f. Design airflow.
 - g. Test velocity.
 - h. Test airflow.
10. Air Distribution Test Sheet:

- a. Air terminal number.
 - b. Room number/location.
 - c. Terminal type.
 - d. Terminal size.
 - e. Area factor.
 - f. Design velocity.
 - g. Design airflow.
 - h. Test (final) velocity.
 - i. Test (final) airflow.
 - j. Percent of design airflow.
11. Terminal Unit Data:
- a. Manufacturer.
 - b. Type, constant, variable, single, dual duct.
 - c. Identification/number.
 - d. Location.
 - e. Model.
 - f. Size.
 - g. Minimum static pressure.
 - h. Minimum design airflow.
 - i. Maximum design airflow.
 - j. Maximum actual airflow.
 - k. Inlet static pressure.
12. Pump Data:
- a. Identification/number.
 - b. Manufacturer.
 - c. Size/model.
 - d. Impeller.
 - e. Service
 - f. Design flow rate, pressure drop, BHP.
 - g. Actual flow rate, pressure drop, BHP.
 - h. Discharge pressure.
 - i. Suction pressure.
 - j. Total operating head pressure.
 - k. Shut off, discharge and suction pressures.
 - l. Shut off, total head pressure.
13. Heat Exchanger:
- a. Identification/number.
 - b. Location.
 - c. Service.
 - d. Manufacturer.
 - e. Model.
 - f. Steam pressure, design and actual.
 - g. Primary water entering temperature, design and actual.
 - h. Primary water leaving temperature, design and actual.
 - i. Primary water flow, design and actual.
 - j. Primary water pressure drop, design and actual.
 - k. Secondary water entering temperature, design and actual.
 - l. Secondary water leaving temperature, design and actual.
 - m. Secondary water flow, design and actual.
 - n. Secondary water pressure drop, design and actual.

14. Cooling Coil Data:
 - a. Identification/number.
 - b. Location.
 - c. Service.
 - d. Manufacturer.
 - e. Air flow, design and actual.
 - f. Entering air DB temperature, design and actual.
 - g. Entering air WB temperature, design and actual.
 - h. Leaving air DB temperature, design and actual.
 - i. Leaving air WB temperature, design and actual.
 - j. Water flow, design and actual.
 - k. Water pressure drop, design and actual.
 - l. Entering water temperature, design and actual.
 - m. Leaving water temperature, design and actual.
 - n. Air pressure drop, design and actual.
15. Heating Coil Data:
 - a. Identification/number.
 - b. Location.
 - c. Service.
 - d. Manufacturer.
 - e. Air flow, design and actual.
 - f. Water flow, design and actual.
 - g. Water pressure drop, design and actual.
 - h. Entering water temperature, design and actual.
 - i. Leaving water temperature, design and actual.
 - j. Entering air temperature, design and actual.
 - k. Leaving air temperature, design and actual.
 - l. Air pressure drop, design and actual.
16. Water Flow Measuring Station:
 - a. Identification/station.
 - b. Location.
 - c. Size.
 - d. Manufacturer.
 - e. Model.
 - f. Design flow rate.
 - g. Design pressure drop.
 - h. Actual/final pressure drop.
 - i. Actual/final flow rate.
 - j. Station calibrated setting.
17. Reheat Coil:
 - a. Manufacturer.
 - b. Type.
 - c. Identification/number.
 - d. Location.
 - e. Model.
 - f. Size.
18. Duct Leak Test:
 - a. Description of ductwork under test.
 - b. Duct design operating pressure.

- c. Duct design test static pressure.
 - d. Duct capacity, air flow.
 - e. Maximum allowable leakage duct capacity times leak factor.
 - f. Test apparatus.
 - 1) Blower.
 - 2) Orifice, tube size.
 - 3) Orifice size.
 - 4) Calibrated.
 - g. Test static pressure.
 - h. Test orifice differential pressure.
 - i. Leakage.
19. Fume Hood, Canopy Hood, and Biological Safety Cabinets:
- a. Identification.
 - b. Location.
 - c. Size.
 - d. Manufacturer.
 - e. Design flow rate.
 - f. Actual/final flow rate.
20. Duct Smoke Detector Test:
- a. Detector Manufacturer.
 - b. Model.
 - c. System Addressable No.
 - d. Indicate Detector Location.
 - e. Indicate Supply/Return/Exhaust Air.
 - f. Indicate Air Handling System.
21. Combination Fire and Smoke Damper Test:
- a. Damper Manufacturer.
 - b. Model.
 - c. System Addressable No.
 - d. Indicate Detector Location.
 - e. Indicate Supply/Return/Exhaust Air.
 - f. Indicate Air Handling System.
22. Variable Frequency Controllers (VFDs):
- a. Location.
 - b. Manufacturer.
 - c. Model.
 - d. Serial number.
 - e. Motor/Equipment designation.
 - f. Horsepower.
 - g. Input voltage.
 - h. Input/Output current at 60 Hz.
 - i. Bypass current.
 - j. Overload setting.
 - k. Acceleration/Deceleration time.
 - l. Skip frequencies.
 - m. Minimum motor speed.
 - n. Interlock for shutdown.

3.4 FINAL TEST REPORT

- A. The final test report shall certify test methods, instrumentation used and test data obtained. Air and water balancing problems encountered, recommendations and uncompleted punch list items shall also be recorded at this time.
- B. A summary of actual operating conditions shall be included with each system outlining normal and/or ventilation cycles of operation. The intent of the final report will provide a reference of actual operating conditions for the Owner's operating personnel.

3.5 PRE-DEMOLITION AIR TESTS

- A. Provide pre-demolition testing of existing systems. Submit bound report of testing results with completed test forms and sketches.
- B. Pre-demolition testing shall include the following:
 - 1. Measure airflow at inlets and outlets including the air inlets above the ceilings.
 - a. Supply, return, and exhaust inlets/outlets for areas directly and indirectly affected by the scope of this project including other floors. The areas, which will be directly affected by this project, are the areas of remodel. The areas indirectly affected by this project are all other areas served by the systems as noted below.
 - b. Where noted on drawings.
 - 2. Measure airflow by traverse readings for the following:
 - a. Supply, return, and exhaust duct serving areas directly and indirectly affected by the scope of this project including other floors. The areas, which will be directly affected by this project, are the areas of remodel. The areas indirectly affected by this project are all other areas served by the systems as noted below.
 - b. Exhaust airflow at shaft openings.
 - c. Supply fans, return fans, exhaust fans, fan discharges and each duct main and duct submain.
 - d. Where noted on drawings.
 - 3. Systems included within the pre-demolition air test are as follows:
 - a. AH201IAH-1
 - b. AH303IAH-2
 - b-c. Kitchen exhaust fans serving existing hoods
 - 4. Procure more complete system distribution layout drawings from the Owner to determine extent of systems. Not all existing ductwork has been shown.

3.6 PRE-DEMOLITION SURVEY OF EXISTING FANS

- A. Provide pre-demolition survey of the existing fan systems as noted above. Submit ~~bound~~ electronic report of survey results with completed survey forms. Include data listed as specified herein.

3.7 EXISTING AIR SYSTEM BALANCE

- A. Upon completion of the demolition and subsequent new work, balance the airflow to the areas affected by the scope of this project to air quantities if shown. If air quantities are not shown, balance to match the pre-demolition conditions.
- B. Adjust the fan systems as required to achieve CFM quantities shown and to match airflow conditions of pre-demolition work.
- C. Follow direction as indicated on drawings.

3.8 DUCT LEAKAGE TESTING

- A. Perform test and record results. Identifying leakage source.
- B. Arrange for equipment necessary to perform test including portable blower, airflow measuring device, flexible tubing, and manometers as required.
- C. Test to be witnessed by Owner's representative.
- D. Systems to be tested are main supply and return air systems and exhaust air systems.
- E. The allowable duct leakage rate shall be as noted in schedule below. Test in accordance with Chapter of the National Standards as written by AABC.
 - ~~1. Constant Volume Systems/Supply Ductwork~~
~~Allowable Leakage – 1 percent of design cfm~~
 - ~~2. Constant Volume Systems/Return Ductwork~~
~~Allowable Leakage – 2 percent of design cfm~~
 - ~~3.1. Variable Constant~~ Air Volume Systems/Supply Ductwork
Fan to ~~C~~VAV Boxes – 1 percent of design cfm
~~C~~VAV Boxes to Registers – 2 percent of design cfm
 - ~~4.2. Variable Constant~~ Air Volume Systems/Return Ductwork
Allowable Leakage – 2 percent of design cfm
- F. Test pressure shall be 1-1/4 times system operating pressure. System operating pressure is the pressure expected during operating conditions for that portion of the system.

3.9 IN-DUCT TYPE, SAMPLING TUBE TYPE AND AREA TYPE SMOKE DETECTOR PROCEDURE

- A. Test each smoke detector and provide data as listed on report forms.
- B. Verify that each detector properly:
 - 1. Operates to detect smoke.

2. Signals the fire alarm system.
 3. Shuts down associated air handling equipment and closes associated combination fire and smoke dampers.
- C. Demonstrate proper operation to the Owners Representative.

3.10 COMBINATION FIRE AND SMOKE DAMPER PROCEDURE

- A. Test 100 percent of the combination fire and smoke dampers and provide data as listed on report forms.
- B. Test damper operation with fusible link and signal from associated smoke detector.
- C. Verify that each damper tested, properly:
1. Operates via detector signal.
 2. Operates via fusible link.
 3. Signals fire alarm system.
 4. Shuts down associated air handling equipment.
- D. Demonstrate proper operation to the Owner's Representative.

END OF SECTION

SECTION 23 07 10
MECHANICAL INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Chilled water piping
- B. ~~Condenser water piping~~
- C. Domestic water piping
- D. Drain piping from cooling coils ~~and electric water coolers~~
- E. Hot water heating piping
- F. ~~Rainwater~~ Stormwater piping
- G. Refrigerant piping
- H. Steam, and condensate return, ~~and boiler feed~~ piping
- I. Semi-instantaneous water heaters
- J. Chilled water pumps
- K. Cold equipment
- L. Hot equipment
- M. Provide thermal and acoustical insulation for the various duct systems described in this Section.

1.2 REFERENCE STANDARDS

- A. Title 24, Part 6 C.C.R.: 2005 Building Energy Efficiency Standards, Sections 123 and 124.
- B. ASTM Standards dealing with insulation materials, jacket materials, and insulation performance.
- C. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
- D. ASTM E119, Standard Method of Fire Test of Building Construction and Materials.
- E. ASTM E814, Standard Method of Fire Tests of Through Penetration Fire Stops.
- F. NFPA 255, Method of Test of Surface Burning Characteristics of Building Materials.
- G. UL 723, Surface Burning Characteristics per ASTM E 84.
- H. UL 1479, Through-Penetration Firestop Test.

1.3 PRODUCT LABELING

- A. Deliver material to job site in original non-broken factory packaging, labeled with manufacturer's density and thickness. Store in clean, dry indoor space that provides protection from the weather.
- B. All products or their shipping cartons or packages shall bear a label indicating that flame and smoke ratings do not exceed requirements as stated in Part 2.

1.4 SUBMITTALS

- A. Submit shop drawings for all insulating and sealing materials provided under this section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Elastomeric foam: Armacell LLC, Halstead, Rubatex.
- B. Fiberglass pipe insulation: Johns Manville, Owens Corning, Knauf.
- C. Fiberglass hydrophilic wicking insulation: Owens Corning "VaporWick", Knauf "PermaWick".
- D. Fiberglass duct and equipment insulation: Johns Manville, Owens Corning, Certainteed, Knauf.
- E. Calcium silicate: Johns Manville, Calsilite, or approved equal.
- F. Polyethylene foam: Therma-cel or approved equal.
- G. Medium temperature Corrosion Resistant Perlite Block Insulation: Industrial Insulation Group (Johns Manville), or approved equal.
- H. High temperature mineral fiber: Johns Manville, Rockwool, Knauf, or approved equal.
- I. Cellular glass: Pittsburgh Corning or approved equal.
- J. Fireproofing wrap: 3M FireMaster, Certainteed FlameChek, or approved equal.

2.2 GENERAL

- A. Unless specifically excluded, all insulation shall have composite (insulation, jacket or facing, and adhesive used to adhere the facing or jacket to the insulation) fire and smoke hazard ratings as tested by Procedure ASTM E-84, NFPA 255 and U/L 723 not exceeding:

Flame Spread	25
Smoke Developed	50 (within air plenums)
Smoke Developed	150 (except within air plenums)
- B. Accessories, such as adhesives, mastics, cements, tapes and glass fabric for fittings shall have the same composite ratings as listed above.

2.3 MATERIALS – PIPING AND EQUIPMENT INSULATION

- A. Jacket and Facing Descriptions:

1. Equal to Johns Manville "AP-T" or Owens-Corning "ASJ" vinyl coated and embossed vapor barrier laminate with pressure sealing lap adhesive, water vapor permeability of 0.02 perms and minimum beach puncture of 40 units. "GVB" glass cloth is also acceptable.
- B. Fitting Covers and Jackets:
1. Equal to Johns Manville Zeston 300 Series PVC heavy-duty fitting covers and jacketing produced from white, glossy, high impact, UV resistant polyvinyl chloride compound. Flame spread/smoke developed of 25/50 or less.
- C. Calcium Silicate Insulation (For ~~Heating Hot Water, Domestic Hot Water, Steam and Steam Condensate. Do not use for Chilled water.~~ Insulation inserts):
1. Equal to Johns Manville Thermo-12 Gold asbestos free, molded, high temperature pipe and block insulation composed of hydrous calcium silicate for systems operating up to 1200° F. Flame spread/smoke developed of 0/0.
 2. ~~Provide all-service jacket for fiberglass pipe insulation, unless noted otherwise.~~
- D. Medium Temperature Corrosion Resistant Block Insulation:
1. Equal to Industrial Insulation Group (John Mansville) Sproule WR-1200 non-wicking perlite block insulation. For use on systems up to 1200° F. Flame spread/smoke developed of 0/0.
 2. Provide all-service jacket for fiberglass pipe insulation, unless noted otherwise.
- E. High Temperature Block Insulation:
1. Equal to Johns Manville Super Caltemp 1700 block insulation made of inorganic noncombustible material. Maximum service temperature of 1700° F. Flame spread/smoke developed of 0/0.
 2. Provide all-service jacket for fiberglass pipe insulation, unless noted otherwise.
- F. Glass Fiber Insulation:
1. Equal to Johns Manville "Micro-Lok", having average thermal conductivity not exceeding 0.23 Btu/In./Sq. Ft./° F./Hr. at mean temperature of 75° F. Glass fiber insulation shall be rated for 850° F.
 2. Reinforced vapor retarder facing and factory applied, longitudinal acrylic closure system. Composite flame/smoke developed of less than 25/50.
 3. Use Micro-Lok AP-T Plus where piping is called to be painted.
- ~~G. Fiberglass Hydrophilic Wicking Insulation:~~
- ~~1. Equal to Owens Corning "VaporWick", Knauf "PermaWick". Rigid molded glass fiber insulation with absorbant hydrophilic wicking cloth that removes water condensing on the pipe or fittings.~~
 - ~~2. Vapor Retarder Jackets:~~
 - ~~a. White polymer jacket with factory supplied holes of size and number appropriate for the jacket circumference. Jacket shall be supplied over pipe insulation in such a manner that when closed properly the holds will align over the wicking cloth to allow for evaporation.~~
 - ~~b.a. PVC jacket and pre-molded fitting covers, punched with the appropriate number of evaporation holes.~~

H.G. Elastomeric Foam Plastic Insulation:

1. Equal to Armacell Type AP Armaflex flame retardant, flame spread/smoke developed of 25/50, elastomeric thermal insulation, installed according to manufacturer's recommendations. Insulation shall be suitable for a pipe temperature range of -40°F to 180°F . Average thermal conductivity not exceeding $0.27\text{ Btu}/\text{In.}/\text{Sq. Ft.}/^{\circ}\text{F.}/\text{Hr.}$ at mean temperature of 75°F .

~~I.H.~~ I.H. High Temperature Glass Fiber Board/Blanket Insulation:

1. Equal to Johns Manville 1000 Series Spin-Glas semi-rigid board having an average thermal conductivity not exceeding $0.23\text{ Btu}/\text{In.}/\text{Sq. Ft.}/^{\circ}\text{F.}/\text{Hr.}$ at mean temperature of 75°F . Glass fiber insulation shall be rated for 850°F .
2. Provide all-service jacket for fiberglass insulation, unless noted otherwise.

~~J.I.~~ J.I. Polyethylene Foam Plastic Insulation:

1. Therma-cel, manufactured by Nomaco, 25/50 fire rated, thermal conductivity of 0.25 At 75°F . mean temperature, maximum temperature limit of 212°F . Seal seams and ends as recommended by manufacturer.

~~K.J.~~ K.J. High Temperature Mineral Fiber:

1. Equal to PAROC 1200, having average thermal conductivity not exceeding $0.23\text{ Btu}/\text{In.}/\text{Sq. Ft.}/^{\circ}\text{F.}/\text{Hr.}$ at mean temperature of 75°F . Mineral fiber insulation shall be rated for 1200°F .

2.4 MATERIALS – DUCTWORK INSULATION

A. Jacket and Facing Descriptions:

1. Equal to Johns Manville "AP-T" or Owens-Corning "ASJ" vinyl coated and embossed vapor barrier laminate with pressure sealing lap adhesive, water vapor permeability of 0.02 perms and minimum beach puncture of 40 units. "GVB" glass cloth is also acceptable.
2. Equal to Johns Manville aluminum foil reinforced with fiber glass scrim laminated to UL rated kraft (FSK) vapor retarder facing having a 2 inch stapling flange on one edge. Water vapor permeability of 0.02 perms.

B. Glass Fiber Insulation Duct Wrap:

1. Equal to Johns Manville "Microlite" fiber glass blanket type duct wrap insulation, FSK faced, having average thermal conductivity not exceeding $0.24\text{ Btu}/\text{In.}/\text{Sq. Ft.}/^{\circ}\text{F.}/\text{Hr.}$ at mean temperature of 75°F . Glass fiber insulation shall be rated for 250°F .

C. Elastomeric Foam Plastic Insulation:

1. Equal to Armacel Type AP Armaflex flame retardant, 25/50 fire rated, elastomeric foam thermal insulation, installed according to manufacturer's recommendations. Insulation shall be suitable for a pipe temperature range of 0°F . to 220°F .

D. Glass Fiber Duct Board Insulation:

1. Equal to Johns Manville 800 Series Spin-Glas semi-rigid board having an average thermal conductivity not exceeding $0.23\text{ Btu}/\text{In.}/\text{Sq. Ft.}/^{\circ}\text{F.}/\text{Hr.}$ at mean temperature of 75°F . Glass fiber insulation shall be rated for 450°F . unfaced side, 150°F . faced side.
2. Provide all-service or FSK jacket.

E. Polyethylene Foam Plastic Insulation:

1. Therma-cel, manufactured by Nomaco, 25/50 fire rated, thermal conductivity of 0.25 At 75° F. mean temperature, maximum temperature limit of 212° F. Seal seams and ends as recommended by manufacturer.

~~F. High Temperature Mineral Fiber:~~

- ~~1. Equal to PAROC 1200, having average thermal conductivity not exceeding 0.23 Btu/in./Sq. Ft./° F./Hr. at mean temperature of 75° F. Mineral fiber insulation shall be rated for 1200° F.~~

~~G.F. Fireproofing Wrap Insulation:~~

1. Equal to Certaineed FlameChek duct insulation. Lightweight, asbestos free, high temperature inorganic foil encapsulated insulation blanket. Used on commercial grease hood duct systems allowing a zero inch clearance to combustible construction and as a 2 hour fire resistive enclosure system when used with a listed or approved through-penetration system.

~~H. External Duct Insulation:~~

- ~~1. Exposed Areas (Rectangular Ducts):~~
 - ~~a. Insulate with minimum 3 pound density fiberglass board with FSK jacket. Cover with an additional jacket of glass cloth, embedded in a thick coat of equal to Benjamin Foster 30-35. Apply another coat of cement over the glass cloth.~~
- ~~2. Exposed Round Ducts:~~
 - ~~a. Round ducts shall be prefabricated rigid glass fiber ducts, 1 inch thick, bearing Underwriter's Laboratories Class I Air Duct label and with glass fiber flame retardant vapor barrier. Standard sheet metal accessories shall be used and all joints covered with 3 inch wide tape.~~
 - ~~b. Cover round ductwork with pre-formed fiberglass pipe covering, with all service jacket. 10 inch diameter and larger ductwork may be covered with equal to Owens-Corning Pipe Wrap semi-rigid fiberglass board insulation with all service jacket.~~
- ~~3. Concealed Areas:~~
 - ~~a. Rectangular and round ducts shall be insulated with minimum 1 pound density fiber glass blanket with foil scrim kraft vapor barrier facing.~~

PART 3 - EXECUTION

3.1 PREPARATION

- A. Apply insulation on surfaces that are clean, dry and free of dirt grease, frost, moisture and other extraneous elements.
- B. Work shall be performed at the temperatures recommended by the product manufacturer.
- C. Do not install covering before piping and equipment have been tested and approved, unless piping contractor assumes full responsibility for removing and repairing any insulation disturbed during the correcting of leaks that may occur.
- D. Seal all canvas and exposed fiberglass insulation with paintable vapor barrier sealer, equal to Chalders CP-11.

3.2 INSTALLATION – GENERAL

- A. All materials shall be installed by skilled tradesmen regularly engaged in this type of work. All materials shall be installed in strict accordance with the manufacturer's recommendations, building codes, and industry standards.

3.3 INSTALLATION – PIPING AND EQUIPMENT

A. Piping and Equipment - General:

1. Butt all insulation sections so that no gaps or spaces exist. Install piping insulation continuous through wall, floor and ceiling openings, sleeves, and hangers.
2. On hot piping, apply 3 inch wide tape or band over butt joints. Staple jacket and tape as necessary to provide proper sealing at longitudinal and circumferential joints or use Owens-Corning insulation with ASJ-SSL-II jacket, having a double self-sealing lap.
3. On cold piping, apply a wet coat of vapor barrier lap cement on all butt joints and seal joints with 3 inch wide vapor barrier tape or band or use equal to Owens-Corning insulation with ASJ/SSL-II jacket, having a double self-sealing lap. If stapling is necessary to provide proper sealing at joints, coat staples with vapor barriers mastic. All penetrations of the vapor barrier jackets and exposed ends of insulation shall be sealed with vapor barrier mastic. When standard fiberglass piping insulation is used, provide vapor seals at butt joints which seal the insulation ends and lap onto the piping, forming a water dam. These shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion.
4. Extend insulation full size through pipe hangers with protection shield at each hanger. Provide a section of calcium silicate ~~for hot piping and perlite block for cold piping~~ at the hanger point, extending 1 inch beyond metal shields. Inserts may be omitted on 1/2 inch piping. Insulation inserts shall be no less than the following lengths:
 - a. 3/4" to 2-1/2" pipe: 10 inches long
 - b. 3" to 6" pipe: 12 inches long
 - c. 8" to 10" pipe: 16 inches long
 - d. 12" and over: 22 inches long
5. Thickness of insulation noted in schedules is minimum acceptable.

~~B. Hydrophilic wicking cloth insulation:~~

- ~~1.6. For horizontal pipes, the evaporation holes shall face down. For vertical pipes, the holes may be oriented in any direction, but shall align from section to section. The wicking cloth shall be visible through all the holes.~~

~~C.B. Fittings, Valves and Flanges:~~

1. Cover with preformed rigid fitting insulation, produced in two halves, or with mitered or fabricated pieces of preformed pipe cover or block. Apply two coats of finishing cement, with reinforcing mesh where required. Do not insulate operating parts of valves.
2. On cold systems, particular care shall be taken to properly vapor seal the fitting cover or pipe insulation where there are protrusions through the vapor barrier jacket. All valve stems shall be sealed with caulking to allow free movement of the stem while providing a seal against moisture incursion.
 - a. ~~On systems calling for hydrophilic wicking cloth piping insulation, wrap all elbows, tees, valves, couplings and other interruptions or changes in directions~~

~~with hydrophilic wicking cloth. Apply wrap at least 2 inches beyond ends of fitting.~~

~~D.C.~~ At Contractor's option and if acceptable to local authorities, install PVC covers, equal to 25/50 Zeston over inserts of fiberglass insulation. Install fitting covers per manufacturer's recommendations. For cold piping, seal all seam edges with vapor barrier mastic and wrap circumferential edges with Zeston's vapor barrier tape.

~~E.D.~~ Insulation at Pipe Support (Inserts):

1. General:
 - a. The thickness of the rigid insulation insert shall be the same as the rest of the pipe insulation.
2. ~~Hot Water, Domestic Hot water, Steam and Steam Condensate Piping~~ All piping systems:
 - a. Provide calcium silicate insulation.
3. ~~Chilled Water Piping, Domestic Cold Water, Glycol Chilled Water, Glycol Process Water, Laser Water Supply and Return, Glycol Heat Recovery Piping:~~
 - ~~a.b.~~ Provide perlite block insulation.

~~F.E.~~ Metal Jacketing:

1. 0.016 inch embossed aluminum jacket with 2 inch overlap at longitudinal and circumferential joints. Secure in place with 3/4 inch x 0.015 inch stainless steel bands on 18 inch centers. For fittings, apply a humped aluminum elbow and band in place. Where flanges or valves are involved, fabricate 0.016 inch aluminum to fit.
2. Apply metal jacketing over piping where exposed to the weather and in specified areas within the building for physical abuse that is insulated with a material other than elastomeric foam.

~~G.F.~~ Weather Barriers:

1. Over elastomeric foam insulation apply two coats of a protective finish as recommended by the manufacturer.
2. Over fiberglass insulation, provide factory applied Hypalon or Tedlar jacket.

~~H.G.~~ Underground Pipe Insulation:

1. Nest supply and return piping together and cover with common 2 inch thick pipe insulation with covering equal to Pittsburgh Corning "Pittwrap" or Polyguard Pipeline Products "Polyguard 800", installed in accordance with manufacturer's recommendations.
2. Therma-cal polyethylene foam plastic.
3. Provide this insulation on underground chilled water supply and return, steam and condensate return.

3.4 INSTALLATION – DUCTWORK

A. Ductwork – General:

1. Install insulation continuous throughout wall, floor and ceiling openings and through sleeves.
2. Duct sizes shown on drawings are net area dimensions and shall be increased as necessary to accommodate duct liner thickness.
3. Ductwork exposed to the weather shall be made waterproof by sealing all seams with hardcast tape, applied according to manufacturer's recommendations. As additional weather protection, apply one coat of aluminum paint to all of the tape.

4. Insulation over angles and standing seams shall be minimum of 1 inch thick. Where angles and standing seams project from ducts, bands of insulation at least 4 inch wide shall be installed to provide adequate coverage.
5. Access panels and doors on surfaces specified to be insulated shall be insulated also unless noted otherwise. Sheet metal covers shall be installed over edges of insulation at access panels or doors, both on the panels or doors and on adjacent surfaces.
6. Heating and cooling coil edges shall be insulated same as adjacent surfaces unless they are installed totally within housings or ductwork. Insulation over removable headers, piping connections, air vents, drains, etc., shall be installed with sheet metal covers which are easily removable for maintenance.

3.5 PIPING TO BE INSULATED

- A. Piping shall be insulated to comply with Section 123 of the 2007 Building Energy Efficiency Standards (Title 24, Part 6 C.C.R.), Table 123-A, where requirements are more stringent in sections below, the more stringent requirements apply.

- B. Domestic Water Piping, Industrial Water Piping (Includes softened and dealkalized water):

1. Insulate all cold, hot and circulating hot water piping with fiberglass pipe covering.

	Insulation Thickness		
	1-1/4" & Smaller	1-1/2" to 2"	2-1/2" & Larger
Cold Water	1"	1"	1-1/2"
Hot Water (Below 140°F.)	1"	1"	1-1/2"
Hot Water (Above 140°F.)	1-1/2"	1-1/2"	2"

2. Flame resistant foam insulation may be used for concealed piping 2 inch and smaller, 1/2 inch thickness.

- C. Deionized or Reverse Osmosis Piping:

1. Where deionized water or reverse osmosis water piping is located above a return air plenum ceiling, insulate the piping with 1 inch thick 1200° F. mineral wool insulation with plenum rated cover.

- D. Tepid water piping: The tepid water piping to emergency eyewashes and showers requires no insulation downstream of the mixing valve.

- E. Drain Piping from Cooling Coils and Electric Water Coolers:

1. Insulate with 1/2 inch thick fiberglass for piping in finished spaces or within air plenum ceilings.
2. 1/2 inch thick foam or 1/2 inch fiberglass shall be used in other concealed spaces.
3. Cover piping from electric water cooler a minimum of 10 feet or to a point where it connects with another waste line.
4. Cover condensate drain piping within 20 feet of drain pans, except where air handling unit is located adjacent to a floor drain.

- ~~F. Chilled Water Piping: Below 40 F:~~

- ~~1. Fiberglass pipe insulation~~

Pipe Size	Insulation Thickness
1" and smaller	1-1/2"
1-1/4" and larger	2"

- ~~2. For piping exposed to ambient conditions, increase thickness by 1/2 inch. Protect insulation as described in Part 3.~~
- ~~3. Piping located indoors in mechanical rooms and tunnels shall be covered with hydrophilic wicking cloth type of insulation system.~~
- ~~4.5. Extend insulation into fan-coil units or other terminal units, terminating over condensate drain pans.~~

G.F. Chilled Water Piping: 40 F and greater:

1. Fiberglass pipe insulation

Pipe Size	Insulation Thickness
1" and smaller	1"
1-1/4" and larger	1-1/2"
2. For piping exposed to ambient conditions, increase thickness by 1/2 inch. Protect insulation as described in Part 3.
- ~~3. Piping located indoors in mechanical rooms and tunnels shall be covered with hydrophilic wicking cloth type of insulation system.~~
- ~~4.3. Extend insulation into fan-coil units or other terminal units, terminating over condensate drain pans.~~

H.G. Low Temperature Hot Water Heating

1. Fiberglass pipe insulation:

Pipe Size	Insulation Thickness
All sizes	1-1/2"

 - a. Insulation thickness on runouts, 2 inch and smaller, to individual terminal units may be reduced to 1/2 inch, within 12 feet of the units.
- ~~2. Calcium silicate insulation can be provided on piping in the following locations:~~
 - ~~a. Mechanical equipment rooms~~
- ~~3. Where calcium silicate insulation is used, thickness shall be in accordance with following schedule:~~

Pipe Size	Insulation Thickness
All sizes	2-1/2"
Runouts 2" and smaller	1"

I.H. Low Pressure Steam, Condensate Return:

1. Fiberglass pipe insulation:

Pipe Size	Insulation Thickness
2" and smaller	1-1/2"
2-1/2" to 6"	2"
8" and larger	3-1/2"

 - a. Insulation thickness on runouts, 2 inch and smaller, to individual terminal units may be reduced to 1 inch, within 12 feet of the units.
- ~~2. Calcium silicate insulation can be provided on piping in the following locations:~~
 - ~~a. Mechanical equipment rooms~~
- ~~3. Where calcium silicate insulation is used, thickness shall be in accordance with the following schedule:~~

Pipe Size	Insulation Thickness
2" and smaller	3"
2-1/2" and larger	3-1/2"

~~a.b. Insulation thickness on runouts, 2 inch and smaller, to individual terminal units may be reduced to 1 inch, within 12 feet of the units.~~

~~J.I.~~ High Pressure Steam Piping:

1. Fiberglass pipe insulation:

251 - 350° F

Pipe Size	Insulation Thickness
1" and smaller	2"
1-1/4" to 4"	2-1/2"
5" and larger	3-1/2"

Greater than 350° F Temperature

Pipe Size	Insulation Thickness
2" and smaller	2-1/2"
2-1/2" to 4"	3"
5" and larger	3-1/2"

- a. Insulation thickness on runouts, 2 inch and smaller, to individual terminal units may be reduced to 1-1/2 inch, within 12 feet of the units.

- ~~2. Calcium silicate insulation can be provided on piping in the following locations:~~

~~a. Mechanical equipment rooms~~

- ~~3. Where calcium silicate insulation is used, thickness shall be in accordance with the following schedule:~~

~~**251 - 305° F. Temperature (15 - 55 psig Steam Pressure)**~~

Pipe Size	Insulation Thickness
4" and smaller	4-1/2"
5" and larger	5"
Runouts 2" and smaller	2-1/2"

~~**306 - 450° F. Temperature (56 - 385 psig Steam Pressure)**~~

Pipe Size	Insulation Thickness
4" and smaller	5"
5" and larger	5-1/2"
Runouts 2" and smaller	2-1/2"

~~K.J.~~ Steam and Condensate Drain Piping from Electric Humidifiers:

1. Cover steam piping from electronic humidifiers to dispersion tubes with 1-1/2 inch thick fiberglass pipe insulation.

~~L.K.~~ ~~Rainwater~~ **Stormwater** Piping:

1. Insulate horizontal ~~rainwater~~ **stormwater** piping, and where the pipe changes from horizontal to vertical insulate the elbow and 3 feet of the vertical, with 1/2 inch thick fiberglass. Insulate roof drain bodies with Armaflex, or equal, 3/4 inch foam flat stock with 25/50 fire rating.

- ~~2. Where electrical heat taping occurs, provide 1 inch thick fiberglass pipe covering.~~

~~M.L.~~ Refrigerant Suction and Hot Gas Piping:

1. Fiberglass pipe insulation:

Pipe Size	Insulation Thickness
1" and smaller	1"
1-1/4" and larger	1-1/2"

2. Foamed plastic flexible tubing insulation of thickness noted for fiberglass, with all joints and seams sealed with cement as recommended by the manufacturer. Cover fittings with sections of the flexible tubing insulation. Where this insulation is exposed to the weather, apply two coats of a protective finish, Benjamin Foster's BF 57-69, or equal.

3.6 EQUIPMENT TO BE INSULATED

A. Chilled Water Pumps:

1. Insulate cold surfaces with 3/4 inch thick flame retardant, elastomeric insulation. Insulation shall be easily removable for routine maintenance of the pumps.

B. Hot Equipment (200°F. Maximum Operating Temperature, Air Separators, Heat Exchangers, Hot Water Storage Tanks, Condensate Receivers, Flash Tanks, Boiler Feed Tank, Solar Water Storage Tanks):

1. Cover all surfaces with fiberglass, minimum 3 pound density, 2 inch thick.
2. Insulation shall be banded in place, tightly butted, joints staggered and secured with 1/2 inch x 0.015 inch thick galvanized steel bands on 12 inch centers. Where required, welded studs, clips or angles shall be provided as anchors for bands.
3. Over the insulation, install ASJ or GVB covering, or stretch 1 inch galvanized hexagonal wire mesh, secured by wiring to anchors with edges tied together. Finish shall be equal to Ryder's Thermokote V insulating cement applied 1/2 inch thick in two coats and troweled smooth. Apply a 10 x 10 glass mesh fabric over the cement, embedded between coats of equal to Benjamin Foster 30-36.
4. Equal to Owens-Corning Fiberglas thermal insulating wool (TIW) may be used in lieu of fiberglass board, but thickness shall be increased to 3 inch.
- ~~5. Calcium silicate insulation may be used in lieu of fiberglass board, but thickness shall be increased to 3-1/2 inch.~~
- ~~6-5.~~ Where operating temperature of equipment is between 200 - 275°F., increase thickness of insulation to 3 inch for fiberglass and to 4 inch for equal to Owens-Corning Fiberglas Pipe Wrap and calcium silicate.

C. Constant Air Volume Box Reheat Coils

1. Cover constant air volume box reheat coil sections with minimum 3 pound density fiberglass insulation, 1 inch thick and finished with ASJ or GVB jacket.

3.7 DUCTWORK TO BE INSULATED

A. Supply-Air and Return-Air ductwork shall be insulated to comply with Section 124 of the ~~2005~~ 2007 Building Energy Efficiency Standards (Title 24, Part 6 C.C.R.). Supply and return air ductwork shall be insulated to a minimum installed level of R-8 for the following locations:

1. Outdoors (i.e. on a roof).
2. In a space between a roof and an insulated ceiling.
3. In a space directly under a roof with fixed vents or opening to the outside or unconditioned spaces.
4. In an unconditioned craw/space.
5. In any unconditioned space (as defined in the E.E.S.).

Supply and Return-Air ducts located in spaces other than the (5) types above shall be insulated to a minimum installed level of R-4.2.

~~B. External Duct Insulation:~~

- ~~1. Apply insulation with edges tightly butted and secured with equal to Benjamin Foster Duct-Fas 81-71 or 3M No. 33 adhesive applied in strips 6 inches wide around duct on 18 inch centers. At all joints the facing shall be lapped over adjacent facing 2 inches and sealed with lap adhesive. Welded pins and clips shall be used on bottom of ducts wider than 24 inches, spaced on not greater than 18 inch centers to hold insulation firmly in place. On round ducts, pins shall be on lower 1/3 of surface.~~
- ~~2. When ducts are exposed, cover them with insulation board with thicknesses as listed and total lengths are intended unless otherwise noted:~~
 - ~~a. Outside Air: 1-1/2" thick.~~
 - ~~b. Mixed Air: 1-1/2" thick.~~
 - ~~c. Return Air: 1-1/2" thick.~~
 - ~~d. Exhaust and Relief Air: 1" thick, within 10 feet of roof or wall opening.~~
 - ~~e. Combination Filter Mixing Boxes: 1-1/2" thick.~~
 - ~~f. Rectangular Supply Air Ducts in Mechanical Rooms: 1" thick.~~
 - ~~g. Drip Pans Beneath Roof Fans: 1" thick.~~
 - ~~h. Supply Air: 1-1/2" thick.~~
- ~~3. When ducts are concealed, cover them with blanket insulation with thickness as listed and total lengths are intended unless otherwise noted:~~
 - ~~a. Outside Air: 3" thick.~~
 - ~~b. Mixed Air: 1-1/2" thick.~~
 - ~~c. Return Air: 1-1/2" thick.~~
 - ~~d. Exhaust and Relief air: 1-1/2" thick, within 10 feet of roof or wall opening, except for kitchen range hood exhaust systems.~~
 - ~~e. Combination Filter Mixing Boxes: 2" thick.~~
 - ~~f. Drip Pans Beneath Roof Fans: 1-1/2" thick.~~
 - ~~g. Supply Air: 1-1/2" thick.~~
- ~~4. Fireproofing Wrap Insulation:~~
 - ~~a. Install fireproofing wrap insulation in accordance with manufacturer's requirements, and using approved components.~~

END OF SECTION

SECTION 23 08 00

SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Procedures and responsibilities to commission the mechanical and plumbing systems for this project.

1.2 REFERENCE STANDARDS

- A. Project Closeout Completion:
 - 1. HVAC Systems Commissioning Manual, ~~1st Edition, October 1994~~ Latest Edition, Sheet Metal and Air Conditioning Contractors' National Association Inc.
 - 2. Guideline for Commissioning of HVAC Systems, ~~#1-1989~~ Latest Edition, American Society of Heating, Refrigerating & Air-Conditioning Engineers, Inc.

1.3 SUBMITTALS

- A. Provide forms for each building mechanical system and system equipment. Forms can be procured through ASHRAE or SMACNA. A representative list of systems is noted below:
 - 1. Checklist – Plumbing Piping Systems.
 - 2. Checklist – Drainage Systems.
 - 3. Checklist – Chilled/Hot Water Systems.
 - 4. Checklist – HVAC: Air Handling Systems.
 - 5. Checklist – Return/Exhaust Fan.
 - 6. Checklist – Heating/Cooling Systems – General.
 - 7. Checklist – Circulating Pump(s).
 - 8. Checklist – Domestic Hot Water Heater.

1.4 DEFINITIONS

- A. Mechanical/Plumbing Building System: A major building utility or equipment system.
- B. Commissioning: To put into active service. The process of advancing facility systems from a state of static physical completion to a state of fully demonstrated and documented working condition according to the design requirements. It consists of accepting a project's construction based on the original performance criteria in the project's specifications, as appropriate.
- C. Commissioning Agent: Personnel responsible for carrying out the detailed planning and implementation of the commissioning process. May be the General Contractor, a sub-contractor and/or an independent contractor selected by the Owner. For this project, the Commissioning Agent shall be the responsibility of the General Contractor.
- D. Commissioning Authority: Personnel responsible for ensuring that the commissioning process is properly completed according to the contract requirements for the project. May be the Project Manager, Architect, or other personnel selected by Owner. For this project, the Commissioning Authority shall be the responsibility of the Owner.

- E. Commissioning Criteria: The specifications, performance data, installation and operation instructions intended function and purpose, and similar requirements as defined by the Architect. These requirements become the criteria to be achieved and documented prior to turnover of a construction project. The requirements are often developed into checklists or other listings for the purpose of documenting that the desired outcome is achieved. Each Building System will likely have its own unique requirements.
- F. Commissioning Package: A group of documents consisting of the approved Commissioning Criteria, approved Commissioning Plan, approved Commissioning Checklist, and any associated documents.
- G. Commissioning Plan: A compilation of the equipment list, pre-start, start-up, and functional performance test checklists. The sequence in which various equipment and systems are checked and tested as well as the time allocated for start-up and testing is included as a portion of the Commissioning Plan (i.e., schedule to complete the commissioning).
- H. Project Team: A work group, which is responsible for the successful design and construction of the project. This group consists of Owner personnel, the Architect, professional design/engineering personnel, general contractor representative, sub-contractor representative, and others as necessary to complete the project.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 DEVELOPMENT OF COMMISSIONING CRITERIA

- A. Submit ASHRAE/SMACNA Commissioning checklist forms for Architect/Engineer use to define system commissioning criteria specific to the project for each system type.
- B. Architect/Engineer shall mark the criteria sheets and return to Commissioning Agent.
- C. Commissioning Agent shall develop individual system criteria checklist sheets.

3.2 CONSTRUCTION COMMISSIONING PROCESS

- A. As construction progresses, the Commissioning Agent shall use the Commissioning Criteria to develop the Commissioning Plan. The Plan, including the following items, shall be submitted for approval of the Commissioning Authority.
 - 1. Criteria to be met for equipment and system performance.
 - 2. Building System(s), start-up and operation information necessary for commissioning process.
 - 3. Functional performance tests to be used in commissioning.
 - 4. Commissioning Checklist(s) to document complete installation, start-up, and operational performance of the Building System(s).
 - 5. Building System(s) commissioning schedule.
- B. The Commissioning Authority shall:
 - 1. Review the Commissioning Plan and compare it to the Commissioning Criteria.

2. Verify that the Commissioning Plan satisfies the Commissioning Criteria.
- C. The Commissioning Agent shall execute the Commissioning Plan.
- NOTE: All sensors, gages, meters, etc., used to measure Building System(s) performance shall be calibrated to National Institute of Standards and Testing (NIST) specifications. If requested, the Commissioning Agent will provide NIST traceable documentation.
1. The Commissioning Authority shall be notified of the schedule and have the opportunity to witness any or all of the work done by the Commissioning Agent.
 2. Commissioning results shall be documented on the checklists by the Commissioning Agent.
- D. The Commissioning Authority shall review the results to verify conformance with the Commissioning Criteria.
1. If the plan is not complete, a punchlist of items not meeting the Commissioning Criteria shall be forwarded to the Commissioning Agent.
- E. The Commissioning Agent shall resolve all items on the punchlist to complete the Commissioning Plan and return it to the Commissioning Authority for review.

3.3 PROJECT DOCUMENTATION

- A. The Commissioning Authority shall assemble the Commissioning Package of documents from the Commissioning Agent.
- B. The Commissioning Authority shall approve the Commissioning Package.
- C. The Commissioning Authority shall forward the approved Commissioning Package to the Architect, Engineer, and Owner for review.

END OF SECTION

SECTION 23 09 00

BUILDING CONTROL SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. ~~Direct Digital Control (DDC) temperature control systems for mechanical equipment requiring control, as described in this Section and as shown on drawings.~~
- B. Direct Digital Control (DDC) temperature control systems for mechanical equipment requiring control, as described in this Section and as shown on the drawings.
- C. ~~Combination fire and smoke dampers or smoke dampers shall be DDC type.~~

1.2 SUBMITTALS

- A. Submit a minimum of eight (8) electronic (PDF) copies of temperature control shop drawings, which include the following information:
 - 1. Manufacturer's catalog data for all components provided and installed for this project. Reference catalog data to the applicable specification article (e.g. 2.02A).
 - 2. AutoCAD or Visio generated schematic drawings for the entire control system. Drawings shall include a diagram depicting the complete system architecture complete with a communications riser, point-to-point wiring diagrams, all temperature controls, start-stop arrangement for each piece of equipment, equipment interlocks, wiring terminal numbers, and any special connection information required for properly controlling the mechanical equipment.
 - 3. Software documentation regarding the proposed PC operating system, third party utilities, and application programs, and the proposed application program for the Control Units.
 - 4. Logical and physical diagrams for each channel indicating each node (control devices and ID's), node address (domain, subnet and group), channel type and router specifications.
 - 5. System color graphics using AutoCAD or Visio generated schematic drawing. Dynamic points, menu icons, commandable points, etc. shall be clearly identified.
 - 6. Identify color conventions proposed for all graphics.
 - 7. Submit temperature control diagrams for each mechanical system served by the HVAC control system. Indicate and tag each input/output served by each control unit or intelligent device. Diagrams shall indicate control device setpoints and ranges.
 - 8. Complete description of control sequences for each system.
- B. Provide as-built diagrams and maintenance manuals to the Owner after completion of the project as required in Section 23 05 00, Common Work Results for HVAC.
 - 1. Control diagrams shall be corrected as necessary to show as-built conditions, including set points and ranges.
 - 2. Include AutoCAD drawings or Visio files of all generated shop drawings on CD-ROM disks.
 - 3. Provide GUI Software users manual.

4. Include network management software user manual to each tool package provided.
5. Document all maintenance and repair/replacement procedures. Provide ordering number for each system component and supply source. Provide a list of recommended spare parts.
6. Provide documentation of network variables, network node configurations, priority interrupts, node binding, addressing structure, etc.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Do not install electronic hardware on the project until non-condensing environmental conditions have been established.
- B. Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping the control devices to the unit manufacturer in a timely manner.
- C. Store and protect against dirt, water, chemical, and mechanical damage.

1.4 ACCEPTANCE PROCEDURE

- A. Upon completion of the installation, the Temperature Controls Contractor shall start-up the system and perform all necessary calibration and testing to ensure the proper operation of the control systems.
- B. After all calibration and testing have been completed, the Contractor shall schedule a hardware demonstration and system acceptance test to be performed in the presence of the system manufacture and designated owner's representatives.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Temperature Control Equipment: ~~Only~~
 1. Siemens Building Technologies
 2. Johnson Controls
 3. Approved equal ~~temperature control equipment will be acceptable, to match existing equipment in the building.~~
- B. Carbon Monoxide/Carbon Dioxide Sensing System: Toxalert, Inc. or approved equal.
- C. Electronic Valve Actuators: Belimo, Siemens, Johnson Control or approved equal.
- D. Electronic Damper Actuators: Belimo or approved equal.
- E. Control Dampers: Ruskin, Johnson Controls, Tamco or approved equal.
- F. Control Valves: Belimo, Delta Control Products, Johnson Control, Siemens or approved equal.
- G. Round Control Dampers: Ruskin, Johnson Controls, or approved equal.
- H. Pressure Independent Flow Control Valves: Flow Control Industries or approved equal.

- I. Flow switches: McDonnell and Miller or approved equal.
- J. Electronic ~~VAV~~CAV Box Air Flow Measuring Stations: Ebtron or approved equal.

2.2 SYSTEM REQUIREMENTS

- A. Provide control systems consisting of thermostats, control valves, dampers, operators, indicating devices, and other apparatus required to operate mechanical system and to perform functions specified.
- B. Provide necessary materials and field work necessary to connect control components factory supplied as part of equipment controlled, unless specified otherwise.
- C. The Temperature Control Contractor shall be responsible for the furnishing and installation of any piping wells or threadolets required for the installation of temperature or pressure sensors associated with his work. Piping wells shall comply with Section 22 05 19, Gauges and Thermometers.
- D. Unless specified otherwise, provide fully proportional components.
- E. All sensing elements shall be installed, calibrated, and tested.
- F. System Manufacture: The system manufacture shall be national recognized and offer a full line of microprocessor based controls. System manufacture shall have installed and maintained projects of similar design for the past 10 years.
- G. Controls Contractor: The controls contractor shall be certified by the system manufacture to install, program and service the system to be provided. The controls contractor must have at least 5 years experience installing similar project and have a servicing field office within 50 miles of this project.
- H. Installation and Commissioning: The controls contractor under supervision of the system manufacture shall install all work of this section. Engineering, programming, calibration and testing shall be preformed by the controls contractor.
- I. The Building Control System shall be a complete system designed for use on Intranets and the Internet. This functionality shall extend into the equipment rooms. Primary nodes located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure existing in the facility. Contractor shall be responsible for coordination with the Owner's IT staff to ensure that the Building Control System will perform in the Owner's environment without disruption to any of the other activities taking place on that LAN.
- J. All points of user interface shall be on standard PCs that do not require the purchase of any special software from the Building Control System manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser ~~such as Internet Explorer or Netscape.~~
- K. Where necessary and as dictated elsewhere in these Specifications, servers shall be used for the purpose of providing a location for archiving system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of a standard data base platform: Microsoft Data Engine (MSDE) or Microsoft SQL Server as dictated elsewhere in this specification.

2.3 ELECTRICAL STANDARDS

- A. The Temperature Control Contractor will be responsible for all control wiring and power wiring required in conjunction with the temperature control system. All electrical components furnished and wiring performed under this section shall comply with standards and practices set forth in Division ~~16-26~~ and, where applicable, furnished components shall be the product of an approved manufacturer listed in that division.
- B. The Temperature Control Contractor shall provide 420V low voltage power as required for stand-alone controllers, ~~VAV~~ CAV-CAV boxes and other equipment as part of this system.
- C. Power shall be fed from 20 amp, 120 volt circuits ~~from nearest electrical panel board. Do not exceed 16 amps per circuit.~~ Refer to electrical drawings for electrical panel allocation. Coordinate the electrical power requirements with the Division ~~16-26~~ contractor to assure proper breaker sizes are available. Any changes in breaker sizes will be the temperature control contractor's responsibility.
- D. All work within the electrical panel boards shall be performed by the original installing contractor. The temperature control contractor shall secure the services of such electrical contractor and coordinate work in a timely manner.
- E. ~~Unless noted otherwise, thermostats and aquastats for unit heaters, and exhaust fans shall be provided by this section and installed under Division 26.~~

2.4 CONTROL PANELS

- A. Provide local panels of unitized cabinet type for each system under automatic control. Mount relays, switches, and controllers with control point adjustment in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.
- B. Fabricate panels from 14 gauge furniture steel with baked enamel finish and hinged key lock door.
- C. Mount panels adjacent to associated equipment on vibration free walls or free standing steel angle supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic name plates for instruments and controls inside cabinet and on cabinet face.
- D. Cabinets shall be UL listed for use with line voltage devices where applicable.
- ~~D-E.~~ All indoor control panels shall have NEMA 1 enclosures. All exterior panels shall have NEMA 4X enclosures.

2.5 THERMOWELLS

- A. Furnish and install thermowells where required for temperature controls and building automation system functions.
- B. Thermowells and sensors shall be mounted in a threadolet or 1/2 inch NPT saddle and allow easy access to the sensor for repair or replacement.
- C. Thermowells shall be constructed of the following materials:
 - 1. Chilled and hot water: Brass.

2. Steam: 316 stainless steel.
- ~~3. Brine (salt solutions): Marine grade stainless steel.~~

2.6 WATER FLOW SWITCHES

- A. UL listed, suitable for the service application intended. Body working pressure shall be equal to or exceed service pressure.
- B. Unit shall have two SPDT switches. Actuating rated flow shall be field adjustable for the specified and indicated service.
- C. Switch location shall preclude exposure to turbulent or pulsating flow conditions. Flow switch shall not cause a pressure drop exceeding 2 psi at maximum flow rate.

~~2.7 SURFACE MOUNTED THERMOSTATS (AQUASTATS)~~

- ~~A. 120 volt surface mounted thermostat designed for mounting on pipes.~~
- ~~B-D. When used as high limit control, the contacts shall open on a rise in temperature. When used as a low limit control, the contacts shall open on falling temperature.~~

~~2.8~~ 2.7 CURRENT TRANSFORMERS (DDC)

- A. Current transformers shall be designed to be installed or removed without dismantling the primary bus or cables. The transformer shall be of a split core design.
- B. Current transformers shall transform power current to a signal that is compatible with the DDC unit. The transformers shall meet the following specifications:
 1. Frequency limits: 50 to 400 Hz.
 2. Insulation: 0.6 KV Class, 10 KV BIL.
 3. Accuracy: $\pm 1\%$ at 5.0 to 25.0 VA accuracy class with UPF burden.
 4. Provide a disconnect switch for each current transformer.

~~2.9~~ 2.8 CURRENT SENSING SWITCHES

- A. Current sensing switch shall be designed to be installed or removed without dismantling the primary bus or cables. The switch shall be of a split core design.
- B. Current sensing switch shall be self-powered with solid state circuitry and a dry contact output. Current sensing switches shall consist of a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept overcurrent up to twice its trip into range.

~~2.10~~ 2.9 ELECTRIC THERMOSTATS

- A. ~~24 volt~~ or ~~120 volt~~ heating only or heating/cooling thermostats as described under Sequences of Operation.
- B. Heating only thermostats SPST switch action with "auto/off/fan" switch. Heating/cooling thermostats with SPDT switch action.

- C. Concealed set point adjustment. Direct or reverse acting as described under Sequences of Operation.
- D. Provide tamperproof covers on all thermostats except those located in mechanical, telephone and electric rooms.

2.442.10 ELECTRONIC TEMPERATURE SENSORS AND TRANSMITTERS

- A. Provide sensors and transmitters required to provide desired control sequences and specified accuracy.
- B. Temperature transmitters shall be equipped with individual zero and span adjustments. The zero and span adjustments shall be non-interactive to permit calibration without iterative operations. Provide a loop test signal to aid in sensor calibration.
- C. Temperature transmitters shall be sized and constructed to be compatible with the monitored medium. Transmitters shall be equipped with a linearization circuit to compensate for non-linearities of the sensor and bridge and provide a true linear output signal.
- D. Temperature sensors shall be of the resistance type and shall be either three wire 100 ohm platinum RTD, or two wire 1000 ohm platinum RTD.
- E. Control system operating software shall be equipped with a self-calibrating feature for temperature sensors.
- F. Provide the following accuracies and operating ranges, and include errors associated with the sensor, lead wire and A to D conversion:
 1. Outdoor air: $\pm 0.5^\circ$ F. Operating range: ~~-300~~-30 $^\circ$ F. to ~~+1300~~+130 $^\circ$ F.
 2. Duct temperature: $\pm 0.5^\circ$ F. Operating range: ~~+400~~-40 $^\circ$ F. to ~~+1400~~-140 $^\circ$ F. for conditioned air, ~~-300~~-30 $^\circ$ F. to ~~+1300~~+130 $^\circ$ F. for unconditioned outdoor air.
 3. Room temperature: $\pm 1.0^\circ$ F. Operating range: ~~+400~~-40 $^\circ$ F. to ~~+1400~~-140 $^\circ$ F.
 4. Chilled water: $\pm 0.5^\circ$ F. Operating range: ~~320~~-32 $^\circ$ F. to ~~900~~-90 $^\circ$ F.
 5. ~~Condenser water: 400 F. to 1400 F. Operating range: 400 F. to 1400 F.~~
 6. Hot water: $\pm 0.5^\circ$ F. Operating range: ~~00~~-0 $^\circ$ F. to ~~2500~~-250 $^\circ$ F.
 7. Low pressure steam: $\pm 0.5^\circ$ F. Operating range: ~~00~~-0 $^\circ$ F. to ~~2500~~-250 $^\circ$ F.
 8. High pressure steam: $\pm 0.5^\circ$ F. Operating range: ~~4000~~-100 $^\circ$ F. to ~~3500~~-350 $^\circ$ F.
 9. Sensors used in BTU or process calculations: $\pm 0.4-1 $^\circ$ F.$
- G. Outdoor air sensors: Sensor shall be designed to withstand the environmental conditions to which they will be exposed. They shall be provided with a solar shield. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate surrounding the sensor element. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
- H. Duct type sensors: Sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate. Mount in a handy box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement. A neoprene grommet (sealtite fitting and mounting plate) shall be used in the sensor assembly to prevent air leaks. Duct sensors probe shall be constructed of 304 stainless steel. For outdoor applications, use weatherproof mounting box with weatherproof cover and gasket.

- I. Averaging duct type sensors: For ductwork greater than 48 inches in any dimension or where temperature stratification exists, utilize an averaging sensor with multiple sensing points. The averaging sensor shall be a 304 stainless steel tube with holes extending across the duct or plenum to be sampled. A bleed hole outside the duct or plenum causes the air to enter the sample tube and exit the bleed hole. The averaging sensor shall be installed complete with end cap, compression fittings, gaskets, mounting flange and required accessories. Provide capillary supports at the sides of the duct to support the sensing string.
- J. Room sensors: Provided with a cover to conceal and protect sensing element. Thermistor with 100 ohm/°F resistance change versus temperature change. Thermistor shall produce 3000 ohms at 77°F for calibration. Provide with vertical base for mounting on a standard single gang junction box.

2.422.11 ELECTRONIC RELATIVE HUMIDITY SENSORS/TRANSMITTERS

- A. Sensor shall be a solid state, resistance type relative humidity sensor of the Bulk Polymer Design. The sensor element shall be washable and shall resist surface contaminations.
- B. Humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2 wire isolated loop powered, 4-20 ma, 0-100 vdc linear proportional output.
- C. The humidity transmitter shall meet the following overall accuracy including lead loss and A to D conversion:
 - 1. Room type sensor: $\pm 3\%$ RH over 0 – 100% RH range.
 - 2. Duct type sensor: $\pm 2\%$ RH over 0 – 100% RH range.
 - 3. High accuracy sensors: $+ 1\%$ RH over 30-80% RH range.
- D. Outdoor air relative humidity sensors shall be installed in a rain proof, perforated cover.
- E. Provide a single point humidity calibrator, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
- F. Duct type sensing probes shall be constructed of 304 stainless steel and be equipped with a neoprene grommet, bushing and a mounting bracket.

2.432.12 ELECTRONIC PRESSURE SENSORS

- A. Solid state sensing element with low hysteresis, excellent repeatability and long term stability.
- B. Zero and span trimmers for field adjustment.
- C. Connect sensors to appropriate interface equipment to perform function intended.

2.442.13 ELECTRONIC DIFFERENTIAL PRESSURE TRANSMITTERS

- A. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage and to hold accuracy when subject to a momentary 40% over-range signal.
- B. Pressure transmitters shall provide the option to transmit a 0 to 5V dc, 0 to 10V dc, or 4 to 20 mA output signal.

- C. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device and shall be supplied with shutoff and bleed valves in the high and low sensing pick-up lines (3 valve manifolds).
- D. Provide a minimum of a NEMA 1 housing for the transmitter. Locate transmitters in accessible local control panels wherever possible.
- E. Low air pressure, differential pressure transmitters used for room pressurization control shall be equipped with a LED display indicating the transmitter output signal.
- F. Duct sensing pressure applications where the velocity exceeds 1500 fpm shall utilize static pressure traverse probes.
- G. Low air pressure application (0 to 0.5 inches W.C.)
 - 1. The pressure transmitter shall be capable of transmitting a linear electronic signal proportional to the differential of the room and reference static pressure input signal with the following minimum performance specifications:
 - a. Span: Not greater than two times the design space differential pressure.
 - b. Accuracy: $\pm 0.5\%$ of full span.
 - c. Dead band: Less than 0.3% of output.
 - d. Repeatability: Within 0.2% of output.
 - e. Linearity: $\pm 0.2\%$ of span.
 - f. Response: Less than one second for full span input.
 - g. Temperature stability: Less than 0.01% output shift per degree F change.
 - 2. The transmitter shall utilize variable capacitance sensor technology and be immune to shock and vibration.
- H. Medium to high air pressure application (0.5 inches to 10.0 inches W.C.)
 - 1. The pressure transmitter shall be similar to the low air pressure transmitter. Provide differential pressure transmitters which meet the following performance requirements:
 - a. Zero and span: (% full scale per degree F): 0.041% including linearity, hysteresis and repeatability.
 - b. Accuracy: 1% of full scale (best straight line).
 - c. Static pressure effect: 0.5% of full scale (to 100 psig)
 - d. Thermal effects: Less than $\pm 0.03\%$ of full scale per degree F over 40° F to 100° F (calibrated at 700° F).
- I. Low differential water pressure applications (0 inches to 20 inches W.C.)
 - 1. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.
 - 2. The differential pressure transmitter shall have a non-interactive zero and span adjustments adjustable from the outside cover and meet the following performance specifications:
 - a. 0.01 to 20 inches W.C. input differential pressure range.
 - b. 4 – 20 mA output.
 - c. Maintain accuracy up to 20 to 1 ratio turndown.
 - d. Reference accuracy: $\pm 0.2\%$ of full span.
- J. Medium to high differential water pressure applications (21 2inches W.C. to 100 psi)

1. The differential pressure transmitter shall meet the low pressure transmitter specifications except the following:
 - a. Differential pressure range 21 inches W.C. to 100 psi.
 - b. Reference accuracy: $\pm 1\%$ of full span (includes non-linearity, hysteresis, and repeatability).
2. Bypass valve assembly: Mount stand-alone pressure transmitters in a bypass valve assemble panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves and compression fitting shall be provided.

2.152.14 WEATHER STATION INSTRUMENTATION

- A. Provide weather monitoring equipment at accessible location where measurements will not be affected by local conditions. Provide weatherproof protection for the sensing elements which shall include:
 1. Outside air temperature, resistance type sensing element shall have a range of ~~-40°~~ 40° F. to ~~140°~~ 140° F. Sensing element shall be interchangeable with ~~+ 4°~~ + 1° F. accuracy at ~~70°~~ 70° F.
 2. Barometric pressure sensing element(s) placed so the measurement signal is unaffected by wind. Use multiple elements in necessary. Measure inches of water column in 0.001 inch units between 310 and 450 inches.

2.162.15 ELECTRONIC DAMPER ACTUATORS

- A. Electronic actuators shall be electric, direct coupled type capable of being mounted over the shaft of the damper. They shall be UL listed. Power consumption shall not exceed 8 watts or 15 VA of transformer sizing capacity per high torque actuator. Damper actuators will not produce more than 62dBA when furnished with a mechanical fail-safe spring. Non-spring return actuators shall conform to a maximum noise of 45dBA.
- B. Electronic overload protection shall protect actuator motor from damage. Internal end switch type actuators are nor acceptable. Actuators may be mechanically end electrically paralleled on the same shaft to multiply the available torque. A reversing switch shall be provided to change action from direct to reverse in relation the control signal as operation requires.
- C. Provide actuators and controllers for Variable Air Volume boxes. Send to the ~~VAV~~ VAVCAV box manufacturer's factory for factory installing. Calibration of those controllers remains the responsibility of the Temperature Control Contractor.
- D. Control damper actuators:
 1. Outdoor air and ventilation air intake and exhaust damper actuators shall be proportional and shall accept a 0-10Vdc or 0-20mA input signal spring return closed. Return air damper actuators shall be proportional and shall accept a 0-10Vdc or 0-20mA input signal spring return open. Other actuators can be drive open, drive closed type two position actuators. The minimum torque for any actuator shall be 50 in-lbs.
 2. Provide auxiliary switches on damper shafts or blade switch to prove damper has opened on all air handling equipment handling 100% outdoor air and greater than 2.5 inches total static pressure.
- E. Air terminal actuators:

1. Actuators shall be minimum 35 in-lb torque and use fully modulating floating (drive open, drive closed) 3 wire control or use control circuit as detailed in control dampers depending on the controllers required.

2.172.16 CONTROL DAMPERS

- A. Dampers supplied under this section shall be sized by the Control Contractor and installed by the Sheet Metal Contractor. Sheet Metal Contractor will provide any required blank-off pieces and inspection doors for proper installation or transitions necessary to accommodate the dampers furnished under this section.
- B. Furnish automatic dampers wherever shown on the drawings or specified herein that are not included as a part of a factory built air handling unit. Provide automatic dampers for exhaust fans unless specifically stated otherwise elsewhere in the specifications or on the drawings.
- C. Outside air and return air dampers for mixing plenums shall be parallel blade dampers arranged to direct the two airstreams together for mixing, unless otherwise noted on drawings. All other throttling dampers shall be opposed blade. Two position dampers can be either parallel or opposed blade type.
- D. Control damper: Equal to Ruskin CD50 low leakage extruded aluminum control damper.
 1. Damper frame: Extruded aluminum (6063T5) hat channel shall not be less than 0.125 inch thickness.
 2. Blades: Heavy gage extruded aluminum (6063T5) airfoil shape.
 3. Blade edge seals: Extruded Ruskiprene (TPR), extruded double edge design with inflatable pocket which enables air pressure from either direction to assist in blade to blade seal off. Seals shall be mechanically locked in extruded blade slots, and shall be easily replaceable on the field.
 4. Frame jamb seals: Flexible metal compressible type.
 5. Bearings: Non-corrosive molded synthetic.
 6. Axles: Hexagonal to provide positive locking connection to blades and linkage. Linkage shall be concealed in frame.
 7. Dampers to be designed for operation in temperatures ranging between -40°F (-40°C) and 212°F (100°C).
 8. Dampers shall be available with either opposed blade action or parallel blade action.
 9. Air leakage through a 48 inch x 48 inch damper shall not exceed 5.2 CFM/sqft. against 4 inches W.G. differential static pressure at standard air. Standard air leakage data to be certified under the AMCA certified ratings program.
 10. Dampers shall be made to size required without blanking off free area.
 11. Installation of dampers shall be in accordance with manufacturer's installation guidelines.
 12. Provide this style of damper at the following areas:
 - a. Outside air and return air dampers for all air handling units except those with factory assembled mixing boxes.
 - b. Pressure reliefs through the roof or wall.
 - c. Combustion air intake.
 - d. Ventilation outside air intake for boiler room, mechanical equipment rooms and elevator equipment rooms.
 - e. Outside air, exhaust air and recirculation air for emergency generator.

f. Exhaust fans where dampers are not provided with fan.

E. Round Control damper: Equal to Ruskin CDRS82 round control damper

1. Damper frame: 16 gage x 8 inches deep stainless steel to 18 inches diameter, 12 gage x 8 inches deep stainless steel 18 inches diameter and over.
2. Blades: Double skin stainless steel 18 gage up to 20 inches diameter, single skin stainless steel 16 gage with retainer ring 26 inches and above. Blade stiffeners as required. Pin angle stop.
3. Blade edge seals: Neoprene.
4. Bearings: Flanged stainless steel pressed into frame.
5. Axles: Stainless steel, 1/2 inch diameter to 24 inches diameter, 3/4 inches above 24 inches diameter.
6. Installation of dampers shall be in accordance with manufacturer's installation guidelines.
7. Provide this style of damper at the following areas:
 - a. Laboratory fume exhaust systems.

2.182.17 SMOKE AND COMBINATION FIRE AND SMOKE DAMPERS

- A. Smoke and combination fire and smoke dampers and actuators will be provided under Section 23 33 00, Ductwork Accessories. This Section will provide interface and connections to those dampers and actuators.

2.192.18 ELECTRONIC VALVE ACTUATORS

- A. Electronic actuators shall be electric, direct coupled type capable of being mounted over the shaft of the damper. They shall be UL listed. Power consumption shall not exceed 8 watts or 15 VA of transformer sizing capacity per high torque actuator. Damper actuators will not produce more than 62dBA when furnished with a mechanical fail-safe spring. Non-spring return actuators shall conform to a maximum noise of 45dBA.
- B. Electronic overload protection shall protect actuator motor from damage. Internal end switch type actuators are not acceptable. Actuators may be mechanically and electrically paralleled on the same shaft to multiply the available torque. A reversing switch shall be provided to change action from direct to reverse in relation the control signal as operation requires.
- C. Control valve actuators – 3 inches and smaller:
 1. Actuators shall have a gear release button on all non-spring return models to allow manual setting. The actuator shall have either an insulating air gap between it and the linkage or a non-conducting thermoplastic linkage. Care shall be taken to maintain the actuator's operating temperatures and humidity within its specifications. Pipes shall be fully insulated and heat shields shall be installed in necessary. Condensation shall not form on actuators and shall be prevented by a combination of insulation, air gap, or thermal break.
 2. The control circuit shall be fully modulating using a 0 – 10 volt or 0 – 20 mA input signal. A 2 to 10 V or 4 to 20 mA signal shall be produced by the actuator which is directly proportional to the shaft position which can be used to control actuators which are paralleled off a master motor or to provide a feedback signal to the automation system indicating valve position.

3. Valve body and actuators shall be shipped fully assembled and tested at the factory prior to shipment.
 4. The manufacture shall provide individual valve identification tagging on each printed valve label. Valve tag identification shall be documented on the approved, submitted valve schedule.
- D. Control valve actuators – 4 inch and larger:
1. Actuator shall consist of a permanent split capacitor, reversible type electric motor which drives a compound epicycle gear. The electric actuator shall have a visible mechanical output indication showing shaft output shaft and valve position. Unit shall be mounted directly to the valves without brackets and adaptors, or readily adapted to suit all other types of quarter-turn valves.
 2. Actuator shall have an integral terminal strip with conduit entries.
 3. Actuator shall be constructed to withstand high shock and vibrations without operations failure.
 4. Actuator shall have a self-locking gear train that is permanently lubricated at the factory. The gear shall be run on ball and needle bearings. Actuators with 600 in-lbs or more output torque shall have two adjustable factory calibrated mechanical torque limit switches of the single pole double throw type. The motor shall be fitted with thermal overload protection. Motor shaft shall run in ball bearings at each end of the motor.
 5. The environmental temperature range of the actuator shall be -20° F to 140° F.
 6. For intermittant on/off service, the actuator shall be rated at a 20% duty cycle (i.e. 12 minutes extended duty in every hour, or alternatively, one complete cycle every 2 minutes). For more frequent cycling and modulating services, an actuator shall be rated for continuous duty. The actuator rated for continuous duty shall be capable of operating 100% of the time at an ambient temperature of 40° C.
 7. The actuator shall have an integral self-locking gear train. Motor brakes shall not be required to maintain desired valve position. Levers or latches shall not be required to engage or disengage the manual override. Mechanical travel stops, adjustable to 15 degrees in each direction of 90 degree rotation shall be standard, as well as two adjustable travel limit switches with electrically isolated contacts. Additional adjustable switches shall be available as an option.
 8. The motor shall have a Class B insulation capable of withstanding lock-rotor for 25 seconds without overheating. Wiring shall be Class B insulation. An auto-reset thermal cutout protector shall be embedded in the motor windings to limit heat rise to 80° C in a 40° C ambient. All motors shall be capable of being replaced by simply disconnecting the wires and then removing mounting bolts. Disassembly of gears shall not be required to remove the motor.
 9. Where continuous feedback of actuator position is required, provide potentiometer with actuator.

2-202.19 CONTROL VALVES

- A. Provide position indicators on valves and pilot positioners on sequenced valves.
- B. Select valves to fail safe in normally open or closed position as dictated by freeze, humidity, fire or temperature protection.

- C. Select two-way valves for liquids to have equal percentage characteristics. Select three-way valves to have linear flow characteristics. Size valve operators to close valves against pump shut-off head. Size water valves for maximum pressure drop of 5 psig. Size steam valves for pressure drop equal to 45% of valve steam inlet pressure.
- D. Valves shall be selected for a maximum flow velocity of 10 ft. per second at the design flow rate with the valve fully open.

2.212.20 PRESSURE INDEPENDENT FLOW CONTROL VALVES

- A. ~~Equal to Delta "P" Valves as manufactured by Flow Control Industries, Inc. modulating pressure independent flow control valves.~~
- B. Flow rate through the valve shall not vary by more than plus/minus 5% due to system pressure fluctuations across the valve in the selected operating range. Control valves shall accurately control the flow from 0 to 100% full rated flow.
- C. Valve rangeability shall be 100:1 minimum.
- D. Valve bodies shall be of cast iron or bronze and rated for 150 PSI. All internal parts shall be of stainless steel, teflon, brass, bronze or cast iron.
- E. Valves shall be servicable without removing them from the piping system (except 1/2 inch). Valve flow characteristics shall be able to be changed without removing the valve from the piping system.
- F. Flow performance curves shall be provided with each valve (except 1/2 inch).
- G. Provide three pressure/temperature ports (Pete's Plugs) in each valve. Two ports shall be used to measure inlet and outlet pressure to the valve. The third port is used to measure internal pressure within the valve.
- H. Temperature Control Contractor shall provide actuator required to properly control valves.

2.222.21 AIRFLOW MEASUREMENT SYSTEMS FOR VAVCAV BOXES

- A. ~~Equal to Ebttron variable air volume box electronic flow sensor.~~
- B. For all variable air volume boxes (supply and exhaust), furnish airflow measurement system as described. The variable air volume (VAVCAV) box air flow measuring stations shall be capable of continuously monitoring airflow rates at each VAVCAV box in order for the host controls to calculate and reset the outside airflow setpoint at the AHU using Equation 6-1 of ASHRAE Standard 62-1999. The system shall consist of one airflow measuring device and matched electronics, which shall be factory tested as a system prior to shipment. The AFMS shall not require recalibration or adjustment over the life of the equipment.
- C. Each sensing point shall measure airflow and use instrument grade, hermetically sealed, glass encapsulated thermistors. Airflow rate sensing shall utilize thermal dispersion technology. Each AFMS shall be wind tunnel calibrated over a range of 0-3,000 FPM. Thermistor resistance/temperature characteristics shall be traceable to NIST standards.
- D. Each measurement location shall produce a single, linear, 0-5 VDC analog output signal for airflow, which can be measured by the host control system. The electronics shall have the ability to automatically reset the microprocessor after transient brownouts and/or after loss of power.

- E. The total accuracy for airflow measurement, including sensing point averaging error and the sum of the sensor and electronic errors shall not exceed $\pm 2\%$ of reading at both minimum and maximum system airflow rates.
1. Electronics: Sensor output signals shall be measured by microprocessor-based electronics, which shall independently calculate and average velocity from each sensing point. The system shall require 24 VAC and the AFMS manufacturer shall provide a 1:1, 24 VAC isolation transformer for each location.
 2. Airflow Measuring Probes: The number of independent sensing points shall be per the manufacturer's recommendation for the specified application and dependent on the location indicated on the plans.
 3. Factory Warranty: 36 months from shipment as described in the manufacturer's Standard Terms & Conditions of Sale.

~~2.23 CARBON MONOXIDE/CARBON DIOXIDE DETECTION SYSTEM~~

- A. ~~Equal to Toxalert GVU-3 detection and control system with the ability to monitor up to three (3) CO and/or CO2 sensors.~~
- B. ~~Provide remote CO sensors as located on drawings. The remote CO sensor(s) shall utilize a solid state sensing element, be micro-processor based and be both temperature and humidity compensated for long life and stability. Pilot lights or LED's shall indicate:~~
1. ~~Unit normal operation/Not alarm~~
 2. ~~High CO/unit in alarm~~
 3. ~~Unit malfunction indication~~
- C. ~~Provide remote CO2 sensor(s) as located on drawings. Sensors shall be solid state infrared detection type for stability and long life with a range of 0 to 2000 ppm maximum. The CO2 sensors shall have LED's to indicate power to unit and alarm condition.~~
- D. ~~The system shall continuously monitor its remote sensors. When an alarm condition is detected the controller shall delay exhaust fan contact closure for 30 seconds. If the high CO/CO2 condition persists for more than 30 seconds the exhaust fan contacts shall close. The minimum fan "on" time shall be field settable from one to eight minutes, in one minute increments. Should the alarm condition remain after the minimum run time has timed out, the exhaust fan contacts shall remain closed ("on") and a second "alarm" set of contacts shall close and send a signal to the BMS.~~
- E. ~~The controller shall have a clock to operate the exhaust fan equipment on a time basis, without high gas level conditions. The fan shall operate from zero to eight minutes (field adjustable in one minute increments) per hour. This fan run shall be separate from the minimum run time setting.~~
- F. ~~The controller shall be designed such that in the event of a power failure the control unit shall set itself to an alarm condition and upon power restoration shall automatically activate the fan output to clear any possible accumulated toxic gases.~~
- G. ~~The controller shall include separate red LED's for each remote sensor to indicate which sensor is indicating a high CO/CO2 condition. A separate LED shall prove, when lighted, that the remote CO sensors have power.~~
- H. ~~Provide the following options for the controller:~~
1. ~~Power "on" LED on face of controller to indicate power to the system.~~

- ~~2. LED on face of panel to indicate high CO/CO2 alarm condition. One for each sensor.~~
- ~~3. Face "on" LED indication.~~
- ~~4. Local alarm horn an/or light. Horn has silence switch.~~
- ~~5. Remote alarm panel.~~
- ~~6. Sensor power indication on face of panel.~~
- ~~7. Calibration kit.~~
- ~~8.4. Keyed panel lock.~~

2.242.22 DIRECT DIGITAL CONTROL UNITS (DDC UNITS)

- A. Direct Digital Control (DDC) units shall be capable of being integrated together with multiple building management, energy management, and historical data collection and archiving.
- B. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- C. Standalone DDC panels shall be able to access any data from, or send control commands and alarm reports directly to any other DDC panel or combination of panels on the network without dependence upon a central processing device. Standalone DDC panels shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.
- ~~D. Networking/Communications:~~
 - ~~1. The design of the DDC units shall permit connecting to a network system and central workstations, as specified under Section 15970, Building Management Systems.~~

E.D. Standalone DDC Panels:

1. General: Standalone DDC panels shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each standalone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the attached point list.
2. Memory: Each DDC panel shall have sufficient memory to support its own operating system and databases including:
 - a. Control processes
 - b. Energy Management Applications
 - c. Alarm Management
 - d. Historical/Trend Data for all points
 - e. Maintenance Support Applications
 - f. Custom Processes
 - g. Operator I/O
 - h. Dial-Up Communications
 - i. Manual Override Monitoring
3. Point Types: Each DDC panel shall support the following types of point inputs and outputs:
 - a. Digital Inputs for status/alarm contacts

- b. Digital Outputs for on/off equipment control.
- c. Analog Inputs for temperature, pressure, humidity, flow, and position measurements.
- d. Analog Outputs for valve and damper position control, and capacity control of primary equipment.
- e. Pulse Inputs for pulsed contact monitoring.

F.E. Expandability: The system shall be modular in nature, and shall permit easy expansion through the addition of software applications, workstation hardware, field controllers, sensors, and actuators. The system architecture shall support % expansion capacity of all types of DDC panels, and all point types included in the initial installation.

G.F. Communication Ports: Standalone DDC panels shall provide a communication port that will allow simultaneous operation of multiple operator I/O devices such as industry standard printers, laptop workstations, PC workstations, and panel mounted or portable DDC panel operator's terminals. Standalone DDC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or network terminals.

H.G. Hardware Override Switches: As indicated in the Point Schedule, the operator shall have the ability to manually override automatic or centrally executed commands at the DDC panel via local, point discrete, on-board hand/off/auto operator override switches for binary control points and gradual switches for analog control type points. These override switches shall be operable whether the panel is powered or not.

I.H. Local Status Indicator Lamps: The DDC panel shall provide local status indication for each binary input or analog output for constant, up-to-date verification of all point conditions without the need for an operation I/O device.

J.I. Integrated On-line Diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis of all subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel, and shall not require the connection of an operation I/O device.

K.J. Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEE Standard 587-1980. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

L.K. Powerfail Restart: The controller shall not require a battery. All configuration data, custom programs, etc., will be stored in non-volatile memory. The controller shall provide a minimum of two days data retention for the time clock and consumable data (runtimes, GPM, KWH, etc.). Systems that require a battery to store data is not acceptable. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention.

2.252.23 SYSTEM SOFTWARE FEATURES

A. General:

1. All necessary software to form a complete operating system as described in this specification shall be provided. The new controls system will supplement the existing building automation system existing in the Campus located in the Central Plant.

2. The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher level computer for execution.
- B. Control Software Description:
1. Pre-tested Control Algorithms: The DDC panels shall have the ability to perform the following pre-tested control algorithms:
 - a. Two-position control
 - b. Proportional control
 - c. Proportional plus integral control
 - d. Proportional, integral, plus derivative control
 - e. Automatic control loop tuning
 2. Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.
 3. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
 4. Powerfail Motor Restart: Upon the resumption of normal power, the DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.
- C. Energy Management Applications: All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Execution portion of this specification. DDC panels shall have the ability to perform any or all of the following energy management routines:
1. Time of Day Scheduling
 2. Calendar Based Scheduling
 3. Holiday Scheduling
 4. Temporary Schedule Overrides
 5. Optimal Start
 6. Optimal Stop
 7. Night Setback Control
 8. Enthalpy Switchover (Economizer)
 9. Peak Demand Limiting
 10. Temperature Compensated Load Rolling
 11. Fan Speed/CFM Control
 12. Heating/Cooling Interlock
 13. Hot Water Reset
 14. Chilled Water Reset
- D. Custom Process Programming Capability: DDC panels shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

1. Process Inputs and Variables: It shall be possible to use any of the following in a custom process:
 - a. Any system-measured point data or status
 - b. Any calculated data
 - c. Any results from other processes
 - d. User-defined Constants
 - e. Arithmetic functions +, -, *, /, square root, exp, etc.
 - f. Boolean logic operations (and, or, exclusive or, etc.)
 - g. On-delay/Off-delay/One-shot timers.
 2. Process Triggers: Custom processes may be triggered based on any combination of the following:
 - a. Time interval
 - b. Time of day
 - c. Date
 - d. Other processes
 - e. Time programming
 - f. Events (e.g. point alarms)
 3. Dynamic Data Access: A single process shall be able to incorporate measured or calculated data from any and all other DDC panels on the local area network. In addition, a single process shall be able to issue commands to points in any and all other DDC panels on the local area network.
 4. Advisory/Message Generation: Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote device such as a printer or pager.
 5. Custom Process Documentation: The custom control programming feature shall be self-documenting. All interrelationships defined by this feature shall be documented via graphic flow charts and English language descriptors.
- E. Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC workstation or local I/O device, or communications with other panels on the network.
1. Point Change Report Description: All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.
 2. Prioritization: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three (3) priority levels shall be provided. Each DDC panel shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.
 3. Report Routing: Alarm reports, messages, and files will be directed to a user-defined list of operator devices, or PC's used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.

4. Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 65-character alarm message to more fully describe the alarm condition or direct operator response. Each standalone DDC panel shall be capable of storing a library of at least two hundred fifty (250) Alarm Messages. Each message may be assignable to any number of points in the panel.
 5. Auto-Dial Alarm Management: In Dial-up Applications, only critical alarms shall initiate a call to a remote operator device. In all other cases, call activity shall be minimized by time-stamping and saving reports until an operator scheduled time, a manual request, or until the buffer space is full. The alarm buffer must store a minimum of fifty (50) alarms.
- F. Historical Data and Trend Analysis: A variety of historical data collection utilities shall be provided to automatically sample, store, and display system data in all of the following ways.
1. Continuous Point Histories: Standalone DDC panels shall store Point History files for all analog and binary inputs and outputs. The Point History routine shall continuously and automatically sample the value of all analog inputs at half hour intervals. Samples for all points shall be stored for the past twenty-four (24) hours to allow the user to immediately analyze equipment performance and all problem-related events for the past day. Point History Files for binary input or output points and analog output points shall include a continuous record of the last ten (10) status changes or commands for each point.
 2. Control Loop Performance Trends: Standalone DDC panels shall also provide high resolution sampling capability with an operator-adjustable resolution of 10-300 seconds in one-second increments for verification of control loop performance.
 3. Extended Sample Period Trends: Measured and calculated analog and binary data shall also be assignable to user definable trends for the purpose of collecting operator-specified performance data over extended periods of time. Sample intervals of one (1) minute to two (2) hours, in one-minute intervals, shall be provided. Each standalone DDC panel shall have a dedicated buffer for trend data, and shall be capable of storing a minimum of five thousand (5000) data samples.
 4. Data Storage and Archiving: Trend data shall be stored at the Standalone DDC panels, and uploaded to hard disk storage when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full. All trend data shall be available in disk file form for user in third party personal computer applications.
- G. Runtime Totalization: Standalone DDC panels shall automatically accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this specification.
1. The Totalization routine shall have a sampling resolution of one (1) minute or less.
 2. The user shall have the ability to define a warning limit for Runtime Totalization. Unique, user-specified messages shall be generated when the limit is reached.
- H. Analog/Pulse Totalization: Standalone DDC panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.
1. Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. KWH, gallons, KBTU, tons, etc.).
 2. The Totalization routine shall have a sampling resolution of one (1) minute or less.

3. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.
- I. Event Totalization: Standalone DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event Totalization shall be performed on a daily, weekly, or monthly basis.
 1. The Event Totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.
 2. The user shall have the ability to define a warning light. Unique, user-specified messages shall be generated when the limit is reached.

2.262.24 APPLICATION SPECIFIC CONTROLLERS - HVAC APPLICATIONS

- A. Each Standalone DDC Controller shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASC's).
- B. Each ASC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.
- C. Each ASC shall have sufficient memory to support its own operating system and databases including:
 1. Control Processes
 2. Energy Management Applications
 3. Operation I/O (Portable Service Terminal)
- D. The operator interface to any ASC point data or programs shall be through any network-resident PC workstation, or any PC or portable operator's terminal connected to any DDC panel in the network.
- E. Application Specific Controllers shall directly support the temporary use of a portable service terminal. The capabilities of the portable service terminal shall include, but not be limited to the following:
 1. Display temperatures
 2. Display status
 3. Display setpoints
 4. Display control parameters
 5. Override binary output control
 6. Override analog setpoints
 7. Modification of gain and offset constants
- F. Powerfail Protection: All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.
- G. Application Descriptions:
 1. ~~VAV~~CAV Terminal Unit Controllers:

- a. **VAVCAV** Terminal Unit Controllers shall support, but not be limited to, the control of the following configurations of **VAVCAV** boxes to address current requirements as described in the Execution portion of this specification, and for future expansion:
 - 1) Single Duct Only (Cooling Only, or Cooling With Reheat)
 - 2) Fan Powered (Parallel/Side Pocket, Series/On-Off Logic)
 - 3) Dual Duct (Constant Volume, Variable Volume)
 - 4) Supply/Exhaust
- b. **VAVCAV** Terminal Unit Controllers shall support the following types of point inputs and outputs:
 - 1) Proportional Cooling Outlets
 - 2) Box and Baseboard Heating Outputs (Proportional, or 1 to 3 Stages)
 - 3) Fan Control Output (On/Off Logic, or Proportional Series Fan Logic)
- c. The modes of operation supported by the **VAVCAV** Terminal Unit Controllers shall minimally include, but not be limited to, the following:
 - 1) Day/Week Schedules
 - 2) Comfort/Occupancy Mode
 - 3) Economy Mode (Standby Mode, Unoccupied, etc.)
 - 4) Temporary Override Mode
- d. Occupancy/Based Standby/Comfort Mode Control: Each **VAVCAV** Terminal Unit Controller shall have a provision for occupancy sensing overrides. Based upon the contact status of either a manual wall switch or an occupancy sensing device, the **VAVCAV** Terminal Unit Controller shall automatically select either Standby or Comfort mode to minimize the heating and cooling requirements while satisfying comfort conditions.
- e. ~~Occupancy-Based Zone Lighting Control: VAV Terminal Unit Controllers shall provide an auxiliary binary output to serve as the interface to an associated lighting relay. Based upon the status of either an occupancy sensing device, or manual wall switch, the VAV Terminal Unit Controller shall provide a contact output to automatically adjust the lighting level to accommodate occupancy requirements while reducing electrical consumption. Standby/Comfort (described in the previous section) and lighting overrides shall be served by the same occupancy override input.~~
- f. Continuous Zone Temperature Histories: Each **VAVCAV** Terminal Unit Controller shall automatically and continuously maintain a history of the associated zone temperature to allow users to quickly analyze space comfort and equipment performance for the past twenty-four (24) hours. A minimum of two (2) samples per hour shall be stored.
- g. Alarm Management: Each **VAVCAV** Terminal Unit Controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

2. Unitary Controllers:

- a. Unitary Controllers shall support, but not be limited to, the following types of systems to address specific applications described in the Execution portion of this specification, and for future expansion:
 - 1) Unit Vents (ASHRAE Cycle I, II, III, or IV)
 - 2) Heat Pumps (Air-to-Air, Water-to-Air)
 - 3) Packaged Rooftops

- 4) Fan Coils (Two-Pipe, Four-Pipe)
- b. Unitary Controllers shall support the following types of point inputs and outputs:
 - 1) Economizer Switchover Inputs:
 - a) Drybulb
 - b) Outdoor Air Enthalpy
 - c) Differential Temperature
 - d) Binary Input from a Separate Controller
 - 2) Economizer Outputs:
 - a) Integrated Analog with Minimum Position
 - b) Binary Output to Enable Self-Contained Economizer Actuator
 - 3) Heating and Cooling Outputs
 - a) One (1) to three (3) stages
 - b) Analog Output with Two-Pipe Logic
 - c) Reversing Valve Logic for Heat Pumps
 - 4) Fan Output
 - a) On/Off Logic Control
 - c. Unitary controllers shall support the following library of control strategies to address the requirements of the sequences described in the Execution portion of this specification, and for future expansion:
 - 1) Daily/Weekly Schedules
 - 2) Comfort/Occupancy Mode
 - 3) Economy Mode:
 - a) Standby Mode/Economizer Available
 - b) Unoccupied/Economizer Not Available
 - c) Shutdown
 - d) Lighting Logic Interlock to Economy Mode
 - 4) Temporary Override Mode:
 - a) Temporary Comfort Mode (Occupancy-Based Control)
 - b) Boost (Occupant Warmer/Cooler Control)
 - d. Occupancy-Based Standby/Comfort Mode Control: Each Unitary Controller shall have a provision for occupancy sensing overrides. Based upon the contact status of either a manual wall switch or an occupancy sensing device, the Unitary Controller shall automatically select either Standby or Comfort mode to minimize the heating and cooling requirements while satisfactory comfort conditions.
 - e. ~~Occupancy-Based Zone Lighting Control: Unitary Controllers shall provide an auxiliary binary output to serve as the interface to an associated lighting relay. Based upon the status of either an occupancy sensing device, or manual wall switch, the Unitary Controller shall provide a contact output to automatically adjust the lighting level to accommodate occupant requirements while reducing electrical consumption. Standby/ Comfort (described in the previous section) and lighting overrides shall be served by the same occupancy override input.~~

- f. Continuous Zone Temperature Histories: Each Unitary Controller shall automatically and continuously, maintain a history of the associated zone temperature to allow users to quickly analyze space comfort and equipment performance for the past twenty-four (24) hours. A minimum of two (2) samples per hour shall be stored.
 - g. Alarm Management: Each Unitary Controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.
3. AHU Controllers:
- a. AHU Controllers shall support, but not be limited to, the following configurations of systems to address current requirements as described in the Execution portion of the specification, and for future expansion:
 - 1) Large Air Handling Units:
 - a) Mixed Air-Single Path
 - b) Mixed Air-Dual Path
 - c) 100% Single Path
 - d) 100% Dual Path
 - b. AHU Controllers shall support all the necessary point inputs and outputs to perform the specified control sequences in a totally standalone fashion.
 - c. AHU Controllers shall have a library of control routines and program logic to perform the sequence of operation as specified in the Execution portion of this specification.
 - d. Occupancy-Based Standby/Comfort Mode Control: Each AHU Controller shall have a provision for occupancy sensing overrides. Based upon the contact status of either a manual wall switch or an occupancy sensing device, the AHU Controller shall automatically select either Standby or Comfort mode to minimize the heating and cooling requirements while satisfying comfort conditions.
 - e. Continuous Zone Temperature Histories: Each AHU Controller shall automatically and continuously, maintain a history of the associated zone temperature to allow users to quickly analyze space comfort and equipment performance for the past twenty-four (24) hours. A minimum of two (2) samples per hour shall be stored.
 - f. Alarm Management: Each AHU Controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

2.272.25 OPERATOR INTERFACE

A. Basic Interface Description:

- 1. Password Protection: Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display and database manipulation capabilities as he deems appropriate for each user, based upon an assigned password.
 - a. Passwords shall be exactly the same for all operator devices, including portable or panel-mounted network terminals. Any additions or changes made to

password definition shall automatically cause passwords at all DDC panels on a network to be updated and downloaded to minimize the task of maintaining system security. Users shall not be required to update passwords for DDC panels individually when they are networked together.

- b. A minimum of five (5) levels of access shall be supported:
 - 1) Level 1 = Data Access and Display
 - 2) Level 2 = Level 1 + Operator Overrides
 - 3) Level 3 = Level 2 + Database Modification
 - 4) Level 4 = Level 3 + Database Generation
 - 5) Level 5 = Level 4 + Password Add/Modification
 - c. A minimum of fifty (50) passwords shall be supported at each DDC panel.
 - d. Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device, including portable or panel mounted devices, shall be limited to only those items defined for the access level of the password used to log-on.
 - e. User-definable, automatic log-off timers of from one (1) to sixty (60) minutes shall be provided to prevent operators from inadvertently leaving devices on-lines.
2. Operator Commands: The operator interface shall allow the operator to perform commands including, but not limited to, the following:
- a. Start-up or shutdown selected equipment.
 - b. Adjust setpoints.
 - c. Add/Modify Delete time programming.
 - d. Enable/Disable process execution.
 - e. Lock/Unlock alarm reporting for each point.
 - f. Enable/Disable Totalization for each point.
 - g. Enable/Disable Tending for each point.
 - h. Override PAD Loop setpoints.
 - i. Enter temporary override schedules.
 - j. Define Holiday Schedules.
 - k. Change time/date.
 - l. Enter/Modify analog alarm limits.
 - m. Enter/Modify analog warning limits.
 - n. View limits.
 - o. Enable/Disable Demand Limiting for each meter.
 - p. Enable/Disable Duty cycle for each load.

B. Standalone DDC Panel or Portable Operator's Terminals:

- 1. Each DDC panel shall be capable of supporting an operator's terminal for local command entry, instantaneous and historical data display, and program additions and modifications.
- 2. There shall be a provision for both permanently mounting the standalone DDC panel operator terminal, or using it as a portable handheld unit.
- 3. The DDC panel operator terminal shall simultaneously display a minimum of six (6) points with full English identification to allow an operator to view single screen dynamic displays depicting entire mechanical systems.
- 4. The operator functions provided by the DDC panel operator terminal shall include, but not be limited to, the following:

- a. Start and Stop Points
 - b. Modify Setpoints
 - c. Modify PAD Loop Setpoints
 - d. Override PAD Control
 - e. Change Time/Date
 - f. Add/Modify Start/Stop Weekly Scheduling
 - g. Add/Modify Setpoint Weekly Scheduling
 - h. Enter Temporary Override Schedules
 - i. Define Holiday Schedules
 - j. View Analog Limits
 - k. Enter/Modify Analog Warning Limits
 - l. Enter/Modify Analog Alarm Limits
 - m. Enter/Modify Analog Differentials
 - n. View Point History Files
5. The DDC panel operator terminal shall provide access to all real or calculated points in the controller to which it is connected, or any other controller in the network. This capability shall not be restricted to a subset of predefined "global points", but shall provide totally open exchange of data between the operator terminal and any DDC panel in the network.
 6. Operator access at all DDC panel operator terminals shall be identical to each other, as well as identical to the PC or Laptop operation workstations. Any password changes shall automatically be downloaded to all controllers on the network.
 7. The DDC panel operator terminal shall provide English language prompting to eliminate the need for the user to remember command formats or point names. Prompting shall be provided consistent with a user's password clearance and the types of points being displayed, to eliminate the possibility of operator error.
 8. A multi-function touchpad shall be provided for point and command selection, as well as parameter entry. To minimize the possibility of operator error, the DDC panel operator terminal shall change and limit touchpad functions based upon an operator's password clearance, the function being performed, and types of points being displayed. Screen displays shall clearly indicate only valid touchpad functions.
 9. Context-Sensitive Help: On-line, interactive user's "Help" manuals and tutorials shall be provided. Based upon operator request, the "help" function shall provide general system operating instructions, and specific descriptions of commands available in the currently displayed menus.
 10. Identification for all real or calculated points shall be consistent for all network devices. The same English language names used at PC workstations shall be used to access points at the DDC panel operator's terminal to eliminate cross-reference or look-up tables.
 11. In addition to instantaneous summaries, the DDC panel operator's terminal shall allow a user to view a Point History file for system points. Point History files shall provide a record of value of analog points over the last twenty-four (24) hours, at 30-minute intervals, or a record of the last ten (10) status changes for binary type points.

PART 3 - EXECUTION

3.1 METHODS

- A. Verify locations of all thermostats and other exposed control sensors with plans and room details before installation. If there is any question about installations, confirm locations with the Architect's on-site representative.
- B. Interlock alarms with starter switching to bypass alarm when equipment is manually disconnected.
- C. The temperature control package shall be completed in a timely manner so that no delay of the project or of the Owner's beneficial occupancy results from the scheduling or performance of this contract.
- D. Install a complete and operable temperature control system which is fully integrated with the BMS and with all factory installed, unit-mounted control packages.

3.2 ELECTRICAL WIRING

- A. Unless specifically stated otherwise, the Temperature Controls contractor is responsible for providing low voltage power ~~from local electrical panels~~ to the control panels. Where systems or devices are to be on emergency power, that electrical power source shall be connected to an emergency power panel. This work shall be coordinated with the Division 246 contractor.
- B. Electrical wiring from sensors to Data Collection Substations and EMCC shall be 24 volts DC, unbroken and continuously shielded to prevent electrical interferences from any external sources and installed in accordance with National Electrical Code and the requirements of the specifications. Wiring shall be moisture proof and color coded. 18 gauge and larger wire shall be stranded.
- C. Furnish and connect electrically operated control system devices, including power supply wiring to transformer primary connection; wiring shall be electrically shielded by metallic conduit of thin wall or rigid type not less than 3/4 inch in diameter.
- D. Circuits operating at more than 50 volts shall be run in metallic conduit.
- E. All electrical work shall be done in conformance with Division 246 of the specifications.

3.3 DEMOLITION OF EXISTING CONTROLS

- A. Remove the existing automatic control system associated with HVAC equipment to be removed, including all wiring, conduit, sensors, panels, damper actuators, etc. Coordinate with the removal of existing HVAC equipment.
- B. Remove all associated points, graphics, etc.
- C. Remove all electrical power and control wiring back to the electrical power panel.
- D. Patch all ductwork, walls, etc. resulting in the removal of the system.

3.4 CONTROL PANELS

- A. Provide separate control panels for the following systems. Other control panels shall include a minimum of 25% spare space for future additions.

3.5 AIRFLOW MEASUREMENT SYSTEMS FOR ~~VAV~~CAV BOXES

- A. Send flow sensors to variable air volume box manufacturer's factory for factory installation.

~~3.6 CARBON MONOXIDE/CARBON DIOXIDE DETECTION SYSTEM~~

- ~~A.B. Install system as per manufacturer's recommendations.~~

~~3.7~~3.6 OPERATION INSTRUCTION

- A. At such time acceptable performance of the building control system hardware and software has been established, provide on-site operator instruction to the Owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent representative familiar with the building control system software, hardware and accessories.
- B. At a time mutually agreed upon, give a minimum of 40 hours of instruction to the Owner's designated personnel on the operation of all equipment associated with the temperature control system. Operator orientation of the control system will include, but not be limited to, the overall operational program, equipment functions (both individually and as part of the total integrated system), commands, advisories, and appropriate operator intervention required in responding to the system's operation. An Owner's manual prepared for this project shall be used in addition to the instruction. Two copies of the Owner's manual shall be provided.

~~3.8~~3.7 WARRANTY AND SERVICE

- A. Refer to Section 23 05 00, Common Work Results for HVAC.

~~3.9~~3.8 MAINTENANCE

- A. Furnish to the Owner a schedule of the maintenance tasks necessary to keep the building management contractor's warranty in effect through the guarantee period. The list of tasks furnished shall indicate a recommended frequency of the preventative maintenance and the necessary tools required to perform the tasks.
- B. Within 30 days after approved operation, present to the Owner for his consideration, a preventative maintenance contract to cover service incidental to the continued proper performance of the Temperature Control(s) and devices during the guarantee period.

~~3.10~~3.9 MAINTENANCE CONTRACT

- A. Submit a maintenance contract price to the building Owner for the system described in this Section of the specification for a one year period, starting at the end of the warranty period.

~~3.11~~3.10 SEQUENCES OF OPERATION

- A. Refer to drawings for Control Sequences of Operation.

END OF SECTION

SECTION 23 09 23

LABORATORY AIR FLOW CONTROL SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide a complete system for the ~~variable air volume control and/or~~ constant volume tracking of laboratory air flow systems.
- B. The laboratory air flow control system shall precisely control the space air supply and exhaust volumes to maintain the desired pressure relationship. Fume hoods shall be controlled to maintain a constant average open sash face velocity regardless of sash position. The laboratory air flow control system shall be capable of operating as a stand-alone system or be integrated with the Building Management System specified under Section 23 09 00.
- C. System shall include, but not be limited to, control panels, supply ~~variable~~ constant air volume boxes, general room exhaust valves, fume hood exhaust valves, air flow sensing stations and fume hood sash position sensors.
- D. The total system shall be installed and commissioned by, or under the direct supervision of, factory trained and authorized field engineers.
- E. The total system shall be installed and commissioned by the Temperature Control Contractor under the direct supervision of factory trained and authorized field engineers.

1.2 JOB CONDITIONS

- A. Coordinate exact sizes and locations of components with the contractor installing the ductwork, temperature controls, and Division 26 work.

1.3 SUBMITTALS

- A. Submit ~~a minimum of eight (8)~~ electronic (PDF) copies of laboratory fume hood control shop drawings, which include the following information:
 - 1. Manufacturer's catalog data for all components provided and installed for this project.
 - 2. AutoCAD or Visio generated schematic drawings for the entire control system. Drawings shall include a diagram depicting the complete system architecture complete with a communications riser, point-to-point wiring diagrams, all temperature controls, start-stop arrangement for each piece of equipment, equipment interlocks, wiring terminal numbers, and any special connection information required for properly controlling the mechanical equipment.
 - 3. Software documentation regarding the proposed PC operating system, third party utilities, and application programs, and the proposed application program for the Control Units.
 - 4. Logical and physical diagrams for each channel indicating each node (control devices and ID's), node address (domain, subnet and group), channel type and router specifications.
 - 5. System color graphics using AutoCAD or Visio generated schematic drawing. Dynamic points, menu icons, commandable points, etc. shall be clearly identified.

6. Identify color conventions proposed for all graphics.
 7. Submit temperature control diagrams for each mechanical system served by the HVAC control system. Indicate and tag each input/output served by each control unit or intelligent device. Diagrams shall indicate control device setpoints and ranges.
 8. Complete description of control sequences for each system.
- B. Provide as-built diagrams and maintenance manuals to the Owner after completion of the project as required in Section 23 05 00, Common Work Results for HVAC.
1. Control diagrams shall be corrected as necessary to show as-built conditions, including set points and ranges.
 2. Include AutoCAD drawings or Visio files of all generated shop drawings on CD-ROM disks.
 3. Provide GUI Software users manual.
 4. Include network management software user manual to each tool package provided.
 5. Document all maintenance and repair/replacement procedures. Provide ordering number for each system component and supply source. Provide a list of recommended spare parts.
 6. Provide documentation of network variables, network node configurations, priority interrupts, node binding, addressing structure, etc.

1.4 QUALITY ASSURANCE

- A. Supplier of this Section systems shall be regularly engaged in the production, assembly, and installation of laboratory fume hood control systems and have a proven track record of a minimum of 5 years.
- B. Supplier of this Section systems shall assume single source responsibility for the complete installation, calibration, and startup of the fume hood tracking systems. Systems shall be left in a completely automated, fully functioning mode of operation.

1.5 WARRANTY

- A. Refer to Section 23 05 00, Common Work Results for HVAC, for warranty requirements. The laboratory air flow control system shall comply with the requirements of that Section, with the added requirement that the equipment and system performance shall be warrantied for a period of three (3) years from the date of final acceptance.

1.6 PREVENTIVE MAINTENANCE

- A. The laboratory air flow control system supplier shall include five (5) years of preventative maintenance (starting at date of final acceptance) on all air flow sensors (e.g. pitot tube, flow cross, orifice ring, air bar, hot wire, vortex shedding, side wall sensors, etc.) and flow transducers provided under this Section. Air flow sensors shall be removed, inspected and cleaned annually during the five year period. The transducer shall be checked and recalibrated annually, even if auto-zero style of transducers. At the conclusion of each annual preventative maintenance inspection, a report shall be turned over to the Owner identifying the work that was completed and identifying any problems and corrective actions taken.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Anemostat Systems Group, Phoenix Controls Corporation Celeris 2, Siemens Building Technologies or approved equal.

2.2 GENERAL

- A. Fume hood tracking system shall use closed loop control to continually monitor and adjust the supply, general room exhaust, and fume hood exhaust volumes. Open loop control systems or systems that can control by pressure only are unacceptable and will not be considered.
- B. Fume hood tracking system shall use either open or closed loop control to continually monitor and adjust the supply, general room exhaust, and fume hood exhaust volumes.

2.3 SYSTEMS DESIGN

- A. In all cases, systems shall failsafe to a mode that achieves the maximum safety to personnel in the spaces served by the systems.
- B. Each individual laboratory shall have a laboratory air flow control system that operates independently of other spaces.
- C. Room pressurization control will be accomplished by volumetric flow synchronization (air flow tracking) or by direct space pressure control, or by a combination of both. Unless specifically identified elsewhere, all systems on this Project shall utilize volumetric flow synchronization as the mode of control. Air flows from the supply, general room exhaust, and fume hood exhaust will be measured and controlled to maintain a safe, comfortable, and energy efficient environment.
- D. Fume hood face velocity control (vertical rising sash) will be used to maintain a preset adjustable face velocity setpoint. Inputs to the controller shall include sash position and fume hood exhaust air flow, from which the controller will calculate the hood face velocity. The minimum hood exhaust flow turndown ration shall be 5 to 1.
- E. The fume hood exhaust air flow control devices shall respond to a changing fume hood sash opening by achieving 90% of the required value within two seconds, and stable condition within five seconds. The rate of sash movement shall be between 1.0 and 1.5 feet per second.
- F. The fume hood exhaust air flow control device shall be automatically switched between in-use and standby levels based on operator presence immediately in front of the hood. A presence and motion sensor shall activate the switching. The response of the air flow device shall be similar to the response for a change in sash position.
- G. A electronic, normally open, rotary damper motor will drive an exhaust valve as required to maintain the fume hood face velocity setpoint.
- H. The volume of the supply air and exhaust air systems will be varied as required to maintain duct static pressure. Control of those systems will be by the Temperature Control Contractor, as specified under Section 23 09 00.

2.4 EQUIPMENT

- A. Hood Interface Module: Equal to Anemostat HMI (Hood Mounted Interface) to provide emergency override, high flow alarm, low flow alarm, hood status lights and audible alarm (95 db at 1 meter). Module designed to fit in a 2 inch by 4 inch (single gang) electrical box and mounted on the face of the fume hood. Connection using phone jack termination. All alarm setpoints shall be fully field programmable as well as the time delay interval prior to alarming. HMI shall also allow high/low sash alarms and limits. All points shall be monitored at the laboratory room control panels and building management system. Alarm and mute functions shall automatically reset when the alarm condition ceases to exist. Alarm annunciation shall be as follows:
1. Normal condition - green LED lighted.
 2. Alarm condition - red LED lighted, indicating either:
 - a. Low face velocity
 - b. High face velocity
 - c. Emergency override
 3. Caution or control transition: green and red LED flash alternately.
 4. Buzzer: energized in any alarm or override condition.
 5. Push button functions:
 - a. Override - Push once
 - b. Reset to normal operation - Push once
 - c. Alarm acknowledgement (audible mute) - Push twice (LED remains lighted while alarm condition exists)
 6. Alarms shall be transmitted over a building communications network to the supervisory system.
- B. Auxiliary emergency override switch: Each laboratory space connected to the laboratory air flow control system shall include a hall mounted emergency override switch, located near the exist door from the space. The switch shall be flush mounted and provided with an engraved label that reads "EMERGENCY VENTILATION – PUSH TO ACTIVATE". Provide a security cover over switch, similar to Safety Technology International, Inc. model STI 6500 clear cover which requires lifting to activate switch. Provide LED indicator lights to indicate position of switch – "green" for normal and "red" for emergency. Label lights accordingly with engraved labels. The switch position shall be transmitted over a building communications network to the supervisory system.
- C. Space and Duct temperature sensors: Refer to Section 23 09 00, Building Control Systems.
- D. Pressure Transmitters: Refer to Section 23 09 00, Building Control Systems.
- E. Sash Position Sensors: Sash position will be sensed using an industrial quality, rotary position transducer connected to the counterweight system of the hood with a stainless steel cable. The sash sensor shall have an expected life of over 250,000 full height sash openings or closings. A sash sensor shall also be provided for horizontal overlapping sashes.
- F. Sash Position Sensor (Through the Wall): Where rotary position transducers cannot be used, and if approved by the Engineer, through the wall flow sensors may be used. These shall be through the wall hot wire flow sensor designed for installation in the upper cavity portion of the fume hood sidewall. Sensor shall be located where room air supply, furnishings, and hood sash will not interfere with its operation and sensing.

- G. Presence and Motion sensor: Provided to determine an operator's presence in front of a hood by detecting the presence and/or motion of an operator. Used to command the laboratory air flow control system from an in-use operating face velocity of 100 fpm to a standby face velocity of 60 fpm, and vice versa.
1. Sensor shall define a detection zone that extended approximately 20 inches from in front of the fume hood. If sensor does not detect presence and/or motion within five seconds, it shall command the system to the user adjustable standby face velocity. When presence and/or motion is detected, it shall command the system to the in-use face velocity.
 2. Sensor shall have a control circuit that adapts to its specific surroundings and automatically adjusts for inanimate objects placed within its detection zone. It shall map the area into memory and, after a period of five minutes, nullify the image of the inanimate object and return to a standby mode. If the inanimate object is moved or taken out of the zone, the unit shall automatically re-map the area.
- H. Flow Transducers: Accuracy shall be no less than $\pm 0.15\%$ of span (to equal $\pm 5\%$ of signal with a 15 to 1 turndown) over the appropriate full scale range including the combined effects of nonlinearity, hysteresis, repeatability, drift over a one year period, and temperature effect.
- I. Laboratory Room Control Panels: Laboratory control panels shall include all control components for the system logic, input signal conditioning, output signal conditioning, power supplied and operator interface. Laboratory control panels shall be located to facilitate maintenance and troubleshooting. Panels shall be of standalone design with the ability to operate the entire laboratory space it serves upon loss of communications from the laboratory network. Each panel shall be fully field programmable, open architecture type. In no case will it be acceptable to mount input or output devices, or system components used for control logic, on the supply variable air volume boxes, general exhaust boxes, or fume hood exhaust boxes. Laboratory control panels shall be located to facilitate maintenance and troubleshooting.
- J. Central Processing Unit (CPU): Industrial quality with the following minimum performance parameters:
1. Scan Rate: The time used by the control system to read a sensor value, calculate a control response, and output a signal to the controlled element shall not exceed 1/2 second. If a communications link is used to pass control information, then the communications rate and protocol lag time must still allow the control loop to obtain the 1/2 second scan rate.
 2. Input Accuracy: To maintain the accuracy of the pressurization control, the input section of the electronics (A/D converter) shall be at least 12 bits (0.024%).
- K. Control Modes: The control system shall incorporate proportional, integral and derivative modes of control.
- L. Air flow controller devices:
1. Microprocessor based and operate using a peer-to-peer control architecture. The room level air flow control devices shall function as a stand-alone network.
 2. The room-level control network shall utilize a LonTalk communications protocol.
 3. Air flow control shall use closed loop control to regulate the air flow based on a digital control signal. The device shall generate a digital feedback signal that represents its air flow.

4. The air flow control device shall store its control algorithms in non-volatile, re-writable memory. The device shall be able to stand-alone or be networked with other room level control devices using industry standard protocol.
 5. The air flow control device shall have provisions to connect to a notebook PC commissioning tool and every node on the network shall be accessible from any point in the system.
 6. The controller shall have built-in integral Input/Output connections to address fume hood control, temperature control, humidity control, occupancy control, emergency control, and non-network sensors, switches and control devices.
 7. The air flow control device shall meet FCC Part 15 Subpart J Class A, and be UL916 listed.
- M. Control Functions: The air flow control devices shall utilize a peer-to-peer, distributed control architecture to perform room level control functions. The minimum control functions included shall be:
1. Pressurization control: Control supply and auxiliary exhaust air flow devices in order to maintain a volumetric offset (either positive or negative). Offset shall be maintained regardless of any changes in flow or static pressure. Offset shall be field adjustable. The pressurization control algorithm shall support the ability to regulate the distribution of total supply flow across multiple supply air flow control devices.
 2. Temperature Control: Regulate the space temperature through a combination of volumetric thermal override and control of reheat coils and/or auxiliary temperature control devices. Separate cooling and heating set points shall be writable from the BMS.
 3. Humidity Control: Allow the monitoring and control of the relative humidity level in the controlled zone. Configurable deadband adjustment to prevent the humidification and dehumidification control functions from operating at the same time.
 4. Occupancy Control: Ability to change the minimum ventilation and/or temperature control setpoints, based on the occupied state. May be set either by the BMS as a scheduled event, or through the use of a local occupancy sensor or switch. System shall support a local occupancy override switch that allows a user to override the occupancy mode and set the space to occupied for a predetermined interval. The local occupancy sensor/switch or bypass switch shall be given priority over a BMS command.
 5. Emergency Mode Control: Provide a means of overriding temperature and pressurization control in response to a command. The emergency control mode may be initiated either by a local contact input or BMS command.
 6. Local Alarm Control: Direct alarms to BMS.
 7. Fume Hood Control: Provide the following information to the BMS:
 - a. Commanded air flow value.
 - b. Sash position value.
 - c. User presence signal.
 - d. Flow feedback signal.
 - e. Alarm signals.
- N. Interface to Building Management System (BMS):
1. All points shall be available through the interface to the BMS for trending, archiving, graphics, alarm notification and status reports.

2. The required software interface drivers to the BMS shall be developed and located in a dedicated interface device furnished by the laboratory air flow control system supplier.
 3. The building level network shall be a high speed LonTalk (1.25 mbps) communications protocol.
- O. Supply ~~Variable~~ Constant Air Volume (CVAVCAV) Boxes: Furnish CVAVCAV boxes as shown on the drawings and specified under Section 23 37 13, Air Distribution Devices. Controls for the CVAVCAV box shall be located in the laboratory control panel for ease of adjustment, calibration, and troubleshooting.
 - P. Supply Box Reheat Coils: Furnish reheat coils as shown on the drawings and specified under Section 23 37 13, Air Distribution Devices.
 - Q. General Room Exhaust Valves: Furnish general room exhaust valves as shown on the drawings and specified under Section 23 37 13, Air Distribution Devices. Controls for the exhaust valves shall be located in the laboratory control panel for ease of adjustment, calibration, and troubleshooting.
 - R. Fume Hood Exhaust Valves: Furnish fume hood exhaust valves as shown on the drawings and specified under Section 23 37 13, Air Distribution Devices. Controls for the exhaust valves shall be located in the laboratory control panel for ease of adjustment, calibration, and troubleshooting.
 - S. All air flow control devices shall be provided with controllers, whether used for constant position or variable position.

2.5 SEQUENCES OF OPERATION

- A. Refer to drawings for Control Sequences of Operation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The laboratory air flow control manufacturer shall be responsible for ensuring that the control system is installed and operates properly as intended and designed.
- B. The Sheet Metal Contractor shall be responsible for the installation of the supply VAVCAV boxes, fume hood exhaust valves, general exhaust valves, air flow sensing stations and any other devices to be installed in the air streams.
- C. The Sheet Metal Contractor shall be responsible for installing duct access doors at each air flow sensor where it is impractical to remove the air flow sensors for servicing.
- D. The Temperature Control Contractor shall be responsible for the mounting of the control panels, wiring the field sensing and interface devices, providing a source of clean, dry, control grade 20 psig air as required, providing appropriately sized and fused 24 Vac transformers suitable for NEC Class II wiring, and all other miscellaneous installation as required for a complete and functioning system. The laboratory control manufacturer shall provide detailed control schematics to the TCC for use in preparing field installation drawings. The TCC shall provide all electrical wiring, pneumatic tubing and miscellaneous installation hardware in addition to labor. The TCC shall utilize cables specifically recommended by the laboratory air flow control supplier.

- E. The laboratory control system supplier shall be responsible for the mounting of the control panels, wiring the field sensing and interface devices, and all other miscellaneous installation as required for a complete and functioning system. The laboratory control manufacturer shall provide detailed control schematics and prepare field installation drawings. Provide all electrical wiring, and miscellaneous installation hardware in addition to labor.
- F. The Division 26 contractor will provide a 120 vac power ~~receptacle~~ for each laboratory control panel.
- G. The laboratory control manufacturer shall send the fume hood interface modules and sash position sensors to the successful fume hood supplier for mounting at the fume hood manufacturer's factory. Provide detailed mounting schematics.

~~3.2~~ MINIMUM QUANTITY OF LABORATORY ROOM CONTROL PANELS

- ~~A. Provide a minimum of one (1) laboratory room control panel for each of the following identified areas:~~

~~3.3.2~~ SYSTEM START-UP

- A. All point to point terminations, setpoint adjustment and calibration, system start-up, and final calibration shall be performed by, or under the direct supervision of, factory trained and authorized field engineers.
- B. Each fume hood system shall be calibrated and tuned to provide safe, efficient, fail-safe operation. Sash position sensors shall be calibrated for sash area, flow transducers shall be calibrated for zero and span, and control loops shall be tuned for each mode of proportional, integral and derivative control. All dampers, damper operators, flow sensors, etc., shall be checked for proper operation. Alarm systems and fail-safe modes shall be checked for each and every device.
- C. Each tracking system shall be calibrated and tuned to provide fail-safe, efficient operation. Flow transducers shall be calibrated for zero and span, the control loop shall be tuned for each mode of proportional, integral and derivative control. All dampers, damper operators, flow sensors, etc., shall be checked for proper operation. The flow volume control system shall be run through its entire range and calibrated as required to linearize the output. Alarm systems and fail-safe modes shall be checked for each and every device.
- D. The laboratory air flow control system supplier shall work closely with the balancing contractor to ensure proper air distribution in the HVAC system. The balancing contractor shall coordinate the work of the hood and tracking systems supplier with the hood certification testing and the HVAC balancing. It is imperative that the methods of testing air flow at the hoods are known and understood by all parties involved. Where there is a conflict as to proper methods to use for balancing, the Engineer shall have the final say.
- E. The Balancing Contractor shall be responsible for providing cfm versus signal data to the laboratory fume hood control system supplier, who will then generate cfm versus signal air flow charts for each box. This data shall be provided to the Owner as a part of the Operation and Maintenance manuals.

~~3.4.3~~ DOCUMENTATION AND TRAINING

- A. The laboratory air flow control supplier shall provide all the documentation and training necessary so that the Owner can be capable of operating and maintaining the control system.

- B. Provide three (3) days of onsite training to personnel designated by the Owner. Training is to include: systems operation, troubleshooting, instrument calibration, alarm handling and system reconfiguration.
- C. Provide five working days of training for three (3) people, of the Owner's choosing, at a factory training site. Transportation, lodging and meals expenses will be at Owner's expense. The training presented shall be the same training that the factory field engineers receive.
- D. Documentation shall consist of dimensional data for control panels, supply boxes, exhaust valves, flow measuring sensors, etc. Control schematics, equipment sizing, instrumentation data sheets and Sequences of Operation shall be included.

3.53.4 COMMUNICATIONS NETWORK

- A. ~~Provide a 56K baud modem with the system to permit offsite monitoring.~~ The laboratory exhaust system shall be capable of remote monitoring via the BMS.

END OF SECTION

SECTION 23 21 23

HVAC PUMPS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Chilled water system pumps
- B. Condensate pumps and accessories
- C. Hot water heating system pumps

1.2 SUBMITTALS

- A. Submit shop drawings on all equipment provided under this section, including certified pump curves showing pump performance characteristics with pump and system operating curves plotted. Include NPSH curve when applicable.

1.3 REFERENCE STANDARDS

- A. ASME (The American Society of Mechanical Engineers).
- B. NEMA (National Electrical Manufacturer's Association).
- C. UL (Underwriter's Laboratories).

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Base mounted and in-line pumps: Bell & Gossett, Armstrong, Aurora, Dunham-Bush, Paco, Peerless, Taco.
- B. Condensate pumps and accessories: Domestic, Dunham-Bush, Roth, Skidmore, Weil.

2.2 GENERAL

- A. Pump construction shall permit complete servicing without breaking piping or disturbing pump motor alignment.
- B. Pumps, casings, flanges and seals shall be suitable for operation with working pressures, temperatures and fluids indicated.
- C. Each motor shall be selected to drive the pump through its characteristic curve from zero flow to 50% above the designed flow, without exceeding rated full load nameplate horsepower. Pump motor nameplate rating shall not be exceeded in pump operation anywhere on the pump curve for specific non-overloading pumps.
- D. Pumps shall have impellers with diameters not exceeding 90% of maximum impeller diameters that are cataloged for the particular casing, or scheduled on the drawings, and shall be capacity tested for design flow after final assembly.
- E. Each pump shall be factory tested and impellers shall be dynamically balanced.

- F. Refer to Section 23 05 13, Motors and Drives, for motor efficiency and power factor requirements.
- G. Pump sizes and capacities as scheduled on drawings.
- ~~H. Equal to Domestic Type "CC" simplex condensate pump.~~
- ~~I.H. Condensate receiver shall be manufactured of cast iron and be equipped with an externally adjustable 2-pole switch, water level gauge, dial thermometer, and pressure gauge for pump discharge.~~
- ~~J.I.~~ A cast iron inlet strainer with easily removable, vertical self-cleaning bronze screen and large dirt pocket shall be mounted on the receiver.
- ~~K.J.~~ Permanently aligned, close coupled vertical pump shall be flange mounted on the receiver. Pump shall be bronze fitted and equipped with stainless steel shaft, enclosed bronze impeller, renewable bronze case ring and mechanical shaft seal. Pump capacity as noted on drawings.
- ~~L.K.~~ Vertically mounted, drip proof ball bearing type motor. Electrical characteristics as noted on drawings.
- ~~M.L.~~ NEMA II, UL listed control cabinet mounted and wired on the pump unit and including:
1. Piano hinged door.
 2. Grounding lug.
 3. Combination magnetic starter (having 3 overload relays) with circuit breaker and cover interlock.
 4. "Automatic-Off" selector switch.
 5. Momentary contact "Test" push button.
 6. Numbered terminal strip.
 7. Removable control mounting plate.
 8. Fusible control circuit transformer for each circuit when the motor voltage exceeds 130 volts.
- ~~N.M.~~ All factory installed wiring shall be numbered for easy identification and the numbers shall coincide with those shown on the wiring diagram.
- ~~O.N.~~ Complete unit shall be factory tested. Manufacturer shall furnish complete elementary and connection wiring diagrams, piping diagrams, installation and operation instructions.

2.3 CONDENSATE PUMP

- A. Equal to Domestic Type "CC" duplex condensate pump or approved equal.
- B. Condensate receiver shall be manufactured of cast iron and be equipped with two externally adjustable 2-pole switches, water level gauge, dial thermometer, pressure gauges for each pump discharge, two bronze butterfly isolation valves for pump capacities up to 75 gpm and bronze gate valves for 75 gpm and over, installed between pumps and receiver, and lifting eye bolts.

- C. A cast iron inlet strainer with easily removable, vertical self-cleaning bronze screen and large dirt pocket shall be mounted on the receiver.
- D. Permanently aligned, close coupled vertical pumps shall be flange mounted on the receiver. Pumps shall be bronze fitted and equipped with stainless steel shaft, enclosed bronze impeller, renewable bronze case ring and mechanical shaft seal. Pump capacities as noted on drawings.
- E. Vertically mounted, drip proof ball bearing type motors. Electrical characteristics as noted on drawings.
- F. NEMA II, UL listed control cabinet mounted and wired on the pump unit and including:
 - 1. Piano hinged door.
 - 2. Grounding lug.
 - 3. Two combination magnetic starters (having 3 overload relays) with circuit breakers and cover interlock.
 - 4. Two "Automatic-Off" selector switches.
 - 5. Two momentary contact "Test" push buttons.
 - 6. Numbered terminal strip.
 - 7. Removable control mounting plate.
 - 8. Fusible control circuit transformer for each circuit when the motor voltage exceeds 130 volts.
- G. Each pump control circuit shall be completely independent of the other.
- H. A manual sequence control (lead-lag) shall provide for:
 - 1. Manual selection of the active pump.
 - 2. Simultaneous operation of both pumps under abnormal load conditions.
 - 3. Automatic operation of the inactive or lag pump if the lead pump or its control fails.
- I. An automatic mechanical alternator shall:
 - 1. Automatically alternate operation of the two pumps.
 - 2. Provide simultaneous operation of both pumps to deliver double the capacity under peak conditions.
 - 3. Automatically operate the second pump should the active pump fail.
- J. An electric alternator shall:
 - 1. Change the operating sequence automatically after each cycle.
 - 2. Provide simultaneous operation of both pumps under peak load conditions.
 - 3. Automatically operate the second pump should the active pump or its control fail.
- K. Provide as a part of the control panel pilot lights to indicate pump running condition.
- L. Provide as a part of the control panel an alarm bell with a separate level control to indicate high water level.
- M. All factory installed wiring shall be numbered for easy identification and the numbers shall coincide with those shown on the wiring diagram.

- N. Complete unit shall be factory tested. Manufacturer shall furnish complete elementary and connection wiring diagrams, piping diagrams, installation and operation instructions.

2.4 BASE MOUNTED PUMPS

- A. Equal to Bell and Gossett Series 1510 or approved equal.
- B. The base shall have provisions for grouting, anchor bolts, and collection of all seal leakage. The base shall have machined surfaces for the mounting of motor and pump. Rigidly anchor base to floor slab through housekeeping pad or to vibration isolation base, as described in Section 23 05 13, Supports, Anchors and Seals. After final alignment, all pumps 25 horsepower and larger shall have pump and motor doweled to the base.
- C. Pump shall be connected to motor through a flexible coupling. Coupling alignment and pump vibration shall be field-checked. Provide factory-manufactured coupling guards which comply with OSHA requirements.
- D. Pumps shall be fitted with grease lubricated type ball bearings, grease fittings and relief plugs.
- E. Pumps shall be vertical split case, flexible coupled, bronze fitted, with front and back wearing rings, shaft sleeves, of single stage centrifugal type and with mechanical seal.
- F. Pumps shall be rated for minimum working pressure of ~~(125)~~ (175) psig.

2.5 IN-LINE PUMPS

- A. Equal to Bell and Gossett Series 80 or approved equal.
- B. Type: Centrifugal, single stage, close coupled, in-line, back pullout design.
- C. Casing: Bronze, rated for minimum of 175 psig working pressure, suction and discharge gauge port, air vent, flanged suction and discharge.
- D. Impeller: Bronze, fully enclosed, keyed to shaft and secured with locknut.
- E. Shaft: Stainless steel or carbon steel with bronze or stainless steel sleeve through seal chamber.
- F. Seals: Standard mechanical seal.
- G. Each pump shall be factory tested and hydraulically and dynamically balanced.

PART 3 - EXECUTION

3.1 PUMP START-UP

- A. Before any pump is started, close balancing valve at discharge of pump and then open it gradually to the operating point of the system. This is to avoid having a pump "run away" with itself on start-up.

3.2 BASE MOUNTED PUMPS

- A. Install base mounted pumps on nominal 4 inch high concrete bases, with base plate grouted in place.

- B. For pumps with packing seals, provide drains from bases and pipe to nearest floor drain. Piping to be copper with soldered fittings.
- C. Provide line size shutoff valve and suction diffuser at pump inlet.
- D. Provide check valve and balancing valve on discharge side of each pump, or use a triple duty valve.
- E. Support piping such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge piping for sizes 4" and larger.
- F. Check alignment between motor and pump and realign if necessary.
- G. Ensure that pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation and operate within 25% of midpoint of published maximum efficiency curve.
- H. Check dynamic balance of pump units and rebalance in field if necessary.
- I. Install flexible pump connectors where noted in Section 23 05 48.

3.3 IN-LINE PUMPS

- A. Provide line size shutoff valve and strainer in suction piping.
- B. Provide check valve and balancing valve on discharge side of each pump, or use a triple duty valve.
- C. Support piping on both sides of in-line pumps. Do not provide permanent support for the pump itself.

END OF SECTION

SECTION 23 22 00

STEAM AND STEAM CONDENSATE PIPING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Steam (0 - 15 psig) piping – Low Pressure Steam
- B. Steam (16 - 125 psig) piping – High Pressure Steam
- C. Condensate return piping

~~1.2 RELATED SECTIONS~~

- ~~A. Section 23 05 00: Common Work Results for HVAC~~
- ~~B. Section 23 05 10: Supports, Anchors and Seals~~
- ~~C. Section 23 05 23: Valves~~
- ~~D. Section 23 05 53: Painting and Identification~~
- ~~E. Section 23 05 48: Vibration Isolation and Seismic Restraints~~
- ~~F. Section 23 07 10: Mechanical Insulation~~
- ~~G.D. Section 23 22 16: Steam and Steam Condensate Specialties~~

~~1.31.2~~QUALITY ASSURANCE

- A. Welding materials and labor shall conform to ASME Code and applicable State labor regulations.
- B. Use welders fully qualified and licensed by State authorities. Welders shall be certified for ASME procedures for high pressure where applicable.
- C. The manufacturer's mark or name shall be attached to each length of pipe, fitting, or device employed in the piping system.

~~1.41.3~~REFERENCE STANDARDS

- A. ANSI (American National Standards Institute).
- B. ASME (The American Society of Mechanical Engineers).
- C. ASTM (American Society for Testing and Materials)
- D. ASTM B813, Water-flushable lead-free flux
- E. ASTM B32, Lead-free alloy solder
- F. ASTM B828, Procedures for soldered joints

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Underground insulated piping: Ric-Wil Incorporated or approved equal.

2.2 PIPE AND FITTINGS

- A. Steam (0 - 15 PSIG):

1. Standard weight black steel, ASTM A-53 Type F or A-53 Type ERW Grade B, or A-106 seamless.
2. 125 pound cast iron screwed fittings, 2-1/2 inch and smaller. Butt welding fittings for 3 inch and larger, ANSI B16.9, with wall thickness identical to pipe in which installed. Flanges shall be Class 150, ANSI B16.5, forged steel, screwed, welding neck or slip-on type as required.

- B. Steam (16 - 125 PSIG):

1. Standard weight black steel, ASTM A-53 Type ERW Grade B or A-106 seamless.
2. 125 pound cast iron screwed fittings, 2-1/2 inch and smaller. Butt welding fittings for 3 inch and larger, ANSI B16.9, with wall thickness identical to pipe in which installed. Flanges shall be Class 150, ANSI B16.5, forged steel, screwed, welding neck or slip-on type as required.

- C. Condensate Return:

1. Schedule 80 black steel pipe, ASTM A-53 Type ERW Grade B or A-106 seamless, with 125 pound cast iron screwed fittings for 2-1/2 inch and smaller and butt welding fittings for 3 inch and larger.

PART 3 - EXECUTION

3.1 SEISMIC RESTRAINTS

- A. Fabricate and support piping in accordance with specifications herein, and latest edition of CMC. Provide seismic restraint in accordance with a current OSHPD pre-approved system that carries a current OSHPD OPA Number. For seismic restraint, see Section 23 05 48.
- B. Install seismic separation assemblies at building seismic joints.

3.2 PREPARATION OF PIPING

- A. Ream pipe ends to remove burrs. Make joints smooth and unobstructed inside. Remove any obstructions or debris inside piping, blowing it out with compressed air or otherwise cleaning it internally immediately prior to assembly.
- B. Cap or cover open piping during erection to prevent entry of foreign objects.

3.3 GENERAL

- A. No lead bearing solders shall be used for assembly of piping specified under this Section. Flux shall be water-flushable and lead-free.

- B. Nipples shall be the same material, composition and weight classification as the pipe with which they are installed. Close or running thread nipples shall not be used.
- C. Install horizontal piping parallel with adjacent walls and partitions unless otherwise shown. All risers shall be plumb. Springing or forcing piping into place will not be permitted unless specifically called for.
- D. Take branches and riser arms off the top of mains at a 45 degree angle, unless otherwise shown.
- E. Use a minimum of two field fabricated or installed fittings or joints when connecting piping to equipment or prefabricated piping assemblies.
- F. Grade piping for drainage using 1 inch drop per 40 feet of run, except where otherwise indicated. Steam and condensate lines shall pitch downward in direction of flow, except where noted otherwise.
- G. Back pitch steam runouts which are less than 10'-0" from steam main. Runouts over 10'-0" from steam main shall be pitched in direction of flow and dripped before control valve.
- H. Provide manual drain valves at low points of condensate return piping. Drains to be 2 inch valves for piping 4 inch and larger and 3/4 inch for smaller piping.
- I. Provide eccentric fittings where necessary to avoid pockets of condensation in steam and gravity condensate return piping. Install driplegs at all rises in pipe elevation. Where condensate lines form a trap, provide vent loop over the trapped section. Install float and thermostatic traps where indicated and at all points where condensate can lodge.
- J. Arrange piping to provide access to coils in piping or ductwork, manholes and access openings, and to permit convenient removal of heads and coils and pulling of tubes. Removal of heads and coils and pulling of tubes shall be accomplished without disturbing equipment shutoff valves and by the removal of a minimum amount of piping between shutoff valves and equipment. Provide additional flanges or unions as required to provide these features.
- K. All control valves shall be set by this Contractor. Piping to control valves shall be run line size as close as possible to valve connections. Concentric increasers at valve outlets may be used. Use eccentric reducers at valve inlets, flat on bottom for steam. Strainers shall be line size. Provide unions or flanges at automatic control valves for servicing.
- L. Piping in finished portions of the building, except in mechanical equipment rooms or where otherwise indicated on the drawings, shall be concealed.
- M. Provide clearance for installation of insulation and for access to valves, air vents, drains and unions.
- N. Install same type underground piping material specified for inside building to 5 feet outside of building.
- O. Do not install piping within 3 feet in horizontal direction from electrical panels or equipment. Coordinate with Division 246 contractor.

3.4 WELDED CONNECTIONS

- A. All welding shall be done in accordance with Chapter V of the American Standard Code for Pressure Piping, ASA B31.3 (as amended to date) unless otherwise noted.

- B. Make welded joints with continuous welds, without backing rings, and with pipe ends beveled before welding. Gas cuts shall be true and free from burned metal. Before welding, welding surfaces shall be thoroughly cleaned. Piping shall be carefully aligned and no weld metal shall project inside the pipe.
- C. Use seamless butt-welding fittings at all elbows, tees and reducers. Mitered or fabricated elbows will not be permitted.
- D. Branch lines at least two pipe sizes smaller than the main may be connected by means of 3000 psig forged steel couplings or "Threadolet" in lieu of welding tees.
- E. Where branch lines are at least two pipe sizes smaller than the main and the main is larger than 3 inch, direct welding to the main may be permitted using a "Threadolet". The welder shall demonstrate to the Owner and/or Engineer, acceptable workmanship with this procedure, including proper matching of branch pipe ends to wall contour of the main.

3.5 CORROSION PROTECTION FOR UNDERGROUND PIPING

- A. After testing of underground piping, apply one heavy coat of coal tar bituminous material, equal to Bitumastic 50, to stainless steel, aluminum, cadmium plated or galvanized steel bolts, rods, banding and other items constructed of these materials.

3.6 EXPANSION OF PIPING

- A. Provide expansion loops where shown on drawings or required to prevent damage to piping and equipment due to thermal expansion in the piping system.
- B. Where loops are shown, the height and width dimensions shall be adhered to where possible. If adjustments are necessary because of interferences with other work, obtain Engineer's approval before proceeding with fabrication of the loop.
- C. Expansion loops shall be all welded steel construction, utilizing long radius elbows.
- D. Install loops with "cold spring" so that loop will have 1/2 of the calculated expansion during normal operation.
- E. Anchor pipe in an approved manner at points shown on drawings, using U-bolt or iron bar clamps secured to the building construction.
- F. Install guides to maintain the position and alignment of piping.
- G. Install runouts from mains and/or risers with swing joints of sufficient length to absorb vertical expansion or contraction of risers and horizontal expansion or contraction of mains.
- H. Where space does not permit installation of expansion loops, provide expansion joints as described in Section 23 22 16, Steam and Steam Condensate Specialties.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, equipment or fixtures.
- J. Install piping connected to equipment to provide flexibility for thermal stresses and for vibration. Adequately support and anchor pipe so that strain from weight and thermal movement of piping is not imposed on the equipment.
- K. Provide piping passing through seismic, expansion, and construction joints with minimum 4 inch deflection capabilities in all directions. Anchor piping on both sides of joint so that

building movement will not cause structural stress on piping supports. Use multiple flexible pipe connectors or seismic separation assemblies to achieve deflection capabilities indicated.

3.7 TESTING OF STEAM AND CONDENSATE RETURN PIPING

- A. Test low pressure steam and condensate return piping with a cold hydrostatic test of not less than 50 psig. Test medium and high pressure steam piping with pressure at 100 psig or 1-1/2 times normal operating pressure, whichever is greater. Test for 24 hours, remove thermostatic elements from traps and other devices that could be damaged by the test pressures. After testing and before replacing trap elements, operate system for 24 hours. Waste condensate to sewer through temporary connections as necessary. If freezing of water could be a problem, air may be used for testing.

3.8 CLEANING OF STEAM AND CONDENSATE RETURN PIPING

- A. After all equipment and piping has been installed, clean piping systems as follows:
 - 1. Flush steam piping systems thoroughly with plant steam.
 - 2. Condensate piping systems: Circulate a solution containing 1 pound of trisodium phosphate per 50 gallons of water for 24 hours, at maximum temperature for each system. Operate all system pumps for a minimum of 50% of the cleaning time.
 - a. Drain system and thoroughly flush with water.
 - b. Fill, operate and drain system repeatedly until clean. Remove mesh elements of strainers at pumps, control valves and elsewhere and clean or replace repeatedly until system can operate continuously with no buildup of dirt on strainer mesh elements.
 - c. After pipe cleaning is completed, flush and inspect all mechanical seals and pump impellers for wear and/or damage and replace same with new parts, if defective.

END OF SECTION

SECTION 23 22 16

STEAM AND STEAM CONDENSATE SPECIALTIES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Condensate meters
- B. Flash tanks
- C. Pressure reducing stations
- D. Pressure regulating valves
- E. Relief valves
- F. Steam flow meters
- G. Steam traps
- H. Strainers
- I. Unions and flanges
- J. Flexible pipe connectors
- K. Flexible expansion loops
- L. Expansion joints
- M. Pipe alignment guides

1.2 REFERENCE STANDARDS

- A. ANSI (American National Standards Institute).
- B. ASME (The American Society of Mechanical Engineers).

1.3 SUBMITTALS

- A. Submit shop drawings on all equipment provided under this section.
- B. Where required, submit certified data sheets for equipment complying with ASME requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Condensate Meters: Badger, Cadillac.
- B. Flash Tanks: Adamson.

- C. Pressure Reducing Valves: Spence, Fisher.
- D. Pressure Regulating Valves: Spirax Sarco.
- E. Relief Valves: Bell and Gossett, Watts or approved equal.
- F. Safety Valves: Kunkle, Crosby.
- G. Steam Flow Meters: BIF, Gervase or approved equal.
- H. Steam Traps: Armstrong, Spirax Sarco, Illinois, Dunham, Trane, Hoffman Specialty or approved equal.
- I. Strainers: Armstrong, Dunham-Bush, Hayward, Metra-Flex, Mueller, Spirax-Sarco, Watts, Hoffman Specialty or approved equal.
- J. Flexible connectors: Hyspan, Mason Industries, Metra-Flex or approved equal.
- K. Flexible expansion loops: Mason Industries, Metra-Flex or approved equal.
- L. Expansion joints: Hyspan, Mason Industries, Metra-Flex or approved equal.
- M. Pipe alignment guides: Hyspan or approved equal

2.2 FLASH TANKS

- A. Tanks equal to ~~Adamson~~ Spirax Sarco or approved equal, designed and constructed to ASME code with required stamping.
- B. Provide complete with steam inlet, outlet, vent and drain connections.
- C. Tanks 12 inches through 20 inches designed and constructed for a maximum working pressure of 150 psig with a 225 psig test.
- D. Tanks over 20 inches designed and constructed for a maximum working pressure of 125 psig with a ~~188~~ 225 psig test.
- E. Steel construction with one ~~eco-coat~~ primer on exterior. Provide inspection openings as required. Provide manholes on tanks 42 inches in diameter and larger.

2.3 PRESSURE REDUCING STATIONS

- A. General:
 - 1. Furnish and install, as shown on drawings, a pressure reducing station to reduce high pressure steam from 100 psig to low pressure steam, ~~using two valves in parallel.~~
 - 2. Each valves shall be 125 pound 450°F. cast iron construction, single seat for dead end service with stainless steel diaphragm and internal trim. It shall be arranged to allow inlet velocities below 10,000 feet per minute and valve capacities shall not to exceed 10% above the required maximum. Valves 2-1/2 inch and larger shall have flanged ends with 125 pound flanges. Smaller valves shall have screwed ends.
 - 3. Noise suppression shall be by a Spence flange-mounted multi-hole plate. Maximum noise produced by the station when measured by the standard method shall not exceed 80 db.

4. Provide gate valves, noise suppression plate, traps, strainers, flash tank and piping as shown on drawings.

B. Pressure Reducing Station:

1. The reducing station shall consist of a pressure reducing valve sized for total capacity ~~with full size bypass.~~
2. ~~Valve shall be, Spence ED, with capacity of Hr.~~
3. Safety Valve: ~~x Kunkle No. 252. Set at 15 psig, with capacity of lb/hr.~~
4. Drip Pan Elbow: size, Kunkle; Figure 299. Pipe condensate discharged drip pan drain to nearest floor drain.

2.4 PRESSURE REGULATING VALVES

- A. Equal to Spirax Sarco ~~Model 25P~~ or approved equal.
- B. Furnish and install, as shown on drawings, pressure regulating valves to reduce steam pressure as indicated.
- C. Valves shall provide maximum capacities shown on the drawings with an accuracy of regulation equal to 1 psi, and allow for variation of the set pressure while in service.
- D. The pilot operated regulator shall be cast iron body. Unit to be self actuating, taking its control signal from the process fluid.
- E. The regulator shall be pilot actuated and diaphragm operated. The regulator shall be packless, single seated globe type suitable for ANSI Class IV shut off.
- F. All regulators shall have hardened stainless steel trim to 38 - 46 Rockwell C scale.
- G. Pilot operated regulators are to consist of two main components, main valve and pressure pilot. Main valve stem shall be top and bottom guided with the bottom guide providing a patent self scrubbing design to minimize sticking. pilots can be top, side or remote mounted with set pressure adjustment by either a spring or air loading force. Trim, spring, stem, guide, and diaphragms shall be stainless steel. Regulators will be threaded, with larger sizes ANSI flanged to meet the system pressure.

2.5 RELIEF VALVES

- A. Equal to Watts Type 174A or 740 or approved equal. ASME rated, with test lever, bronze bodies, selected for a relief pressure applicable with the installation.

2.6 STEAM TRAPS

A. Low Pressure Steam Traps:

1. Provide float and thermostatic traps for low pressure steam service. Traps with integral strainers are acceptable.
2. Steam traps shall be sized ~~in accordance with following tables,~~ based on actual capacity of steam trap at 1/2 psig pressure differential across trap. In a case where actual pressure differential is known and is greater than 1/2 psig, this pressure may be used for sizing.

Trap Size - Inches	Cap. (#/Hr. at 1/2 psig Diff.)
3/4	100

1	250
1-1/4	600
1-1/2	1200
2	2500

- a. Size for 3 to 1 safety factor for the following items:
- 1) Preheat coils
 - 2) Shell and tube heat exchangers (steam in shell)
 - 3) Unit heaters
 - 4) Reheat coils
 - 5) Storage water heaters

B. Drip Traps - High or Low Pressure:

1. Provide float and thermostatic trap or inverted bucket trap with thermic vent for low pressure drips and inverted bucket traps without thermic vents for high pressure drips. Following schedule shall apply to steam main drip traps.

2. ~~Low Pressure Steam to 15 psig:~~

~~Steam Main Size Trap Capacity at 15 psig~~

1" - 10"	600 lb/hr
12" - 24"	1060 lb/hr

3. ~~High Pressure Steam 15 psig to 250 psig:~~

~~Steam Main Size Trap Capacity at 25 psig~~

1" - 10"	750 lb/hr
12" - 16"	1300 lb/hr
18" - 24"	3000 lb/hr

C. Low Pressure Thermostatic Traps:

1. Traps shall have multiple seamless bellows type thermostatic elements, stainless steel head and removable seat.
2. Trap sizes and capacities shall be in accordance with the following table:

~~Trap Size Capacity(Lb/Hr @ 1/2 PSIG Diff.)~~

1/2"	28
3/4"	55
1"	98

2.7 STRAINERS

- A. Y-type strainer designed for line pressure serving coil with strainer ahead of control valve in steam supply to coil. Strainers shall be designed for line pressure.

2.8 UNIONS AND FLANGES

- A. For systems with pressures less than 150 psig, use 150 pound malleable iron ground joint unions, ANSI B16.39, in steel piping 2 inch and smaller. For the same piping 2-1/2 inch and larger, use cast iron flanges, Class 125.
- B. For systems with pressures 150 - 300 psig, 300 pound malleable iron ground joint unions in steel piping 2 inch and smaller. For same piping 1-1/2 inch and larger, use cast iron flanges, Class 250.

- C. Provide gaskets and bolts for flanges, as required for the temperature and pressure of the piping system.

2.9 FLEXIBLE CONNECTORS

- A. Provide flexible piping connectors at the following locations or where indicated on drawings.
 - 1. Vibration isolation.
 - 2. Misalignment compensation.
- B. For steel piping application use Hyspan Series 4500 with an inner hose of annular corrugated stainless steel, an exterior sleeve of braided stainless steel, a pressure rating of 300 pounds per square inch gauge, joints for 2 inch diameter and larger shall be flanged and for smaller than 2-inch diameter shall be threaded with unions. Size shall be same size as piping connected to.

2.10 FLEXIBLE EXPANSION LOOPS

- A. Provide flexible piping connectors at the following locations or where indicated on drawings.
 - 1. Seismic joint.
 - 2. Building expansion joint.
 - 3. Building construction joint.
- B. Expansion joints shall be of the braided stainless steel type. Joints to consist of two flexible sections of hose and braid, two 30° elbows, and a 60° return. Flexible hose section to be stainless steel, close pitch, annular corrugated hose with a braided outer covering of stainless steel. End connections to match mating piping. The overall length shall allow for a minimum of ± 4 " movement in any direction. Expansion joints shall be equal to Mason Industries model "VFL" for flanged, "VCPS" for copper, "VMN" for male thread, "VGN" for grooved.

2.11 EXPANSION JOINTS

- A. For steel piping 3 inch and smaller, provide stainless steel bellows type expansion joints at locations indicated on drawings. Units to be Hyspan Series 1500 or equal with a pressure rating of 150 pounds per square inch gauge and 750 degrees F., maximum compression as indicated on drawing schedule, joint as specified for pipe joints, size shall be same size as piping.
- B. For steel piping larger than 3 inch, provide externally pressurized guided stainless steel bellows type expansion joints at locations indicated on drawings. Units to be Hyspan Series 3500 or equal with a pressure rating of 300 pounds per square inch gauge and 750 degrees F., maximum compression as indicated on drawing schedule, flanged joints, size shall be same size as piping.

2.12 PIPE ALIGNMENT GUIDES

- A. Provide pipe alignment guides equal to Hyspan Series 9500. Guides to be pressed steel joined together by fusion welding with a protective black lacquer paint finish.

PART 3 - EXECUTION

3.1 FLASH TANKS

- A. Install in accordance with manufacturer's recommendations. Provide steel support framing as required.

3.2 INSTALLATION OF PRESSURE REDUCING STATIONS

- A. Use Schedule 80 pipe at the pressure reducing stations and within a minimum distance of 20 feet upstream and downstream of the reducing stations, to aid in noise suppression.
- B. Pressure Gauges:
 - 1. Provide a pressure gauge on all inlets and outlets of reducing station and every other point of pressure change.
 - 2. Gauges shall have a range equal to 1-1/2 times the highest operating pressure and be as specified in Section 22 05 19, Gauges and Thermometers.

3.3 INSTALLATION OF PRESSURE REGULATING VALVES

- A. Install per manufacturers recommendations. Set to pressures indicated on drawings.
- B. Pressure Gauges:
 - 1. Provide a pressure gauge on all inlets and outlets of each regulating valve.
 - 2. Gauges shall have a range equal to 1-1/2 times the highest operating pressure and be as specified in Section 22 05 19, Gauges and Thermometers.

3.4 RELIEF VALVES

- A. Pipe discharge from relief valves to an area that will afford protection to people in the vicinity in the event of relief valve discharge.

3.5 INSTALLATION OF STEAM TRAPS

- A. Provide steam trap on condensate return side of all equipment utilizing steam, ahead of steam control valves and to drip low points in the piping.
- ~~B. Run condensate piping from traps at humidifiers to be wasted at floor drains, unless shown connected to condensate return system.~~
- ~~C-B. Installation of each steam trap shall be as follows, starting at condensate leg; gate valve, union, strainer, trap and gate valve. Omit strainer where trap is serving coil with strainer ahead of control valve in steam supply to coil.~~
- ~~D-C. Drip traps shall be provided at end of steam mains, at base of vertical risers, ahead of expansion joints, valves and pressure regulators. Following schedule shall apply to steam main drip traps. Provide a trap every 300 feet for both low and high pressure steam mains.~~
- ~~E-D. Drip legs shall be 5 inch long and pipe diameter of main or apparatus return to 4 inch in pipe size and on steam lines over 4 inch in diameter, drip leg of not less than 4 inch shall be used. Installation of each steam trap used on drip legs shall be as follows, starting at condensate leg; gate valve, union, strainer, steam trap and gate valve.~~

F-E. Provide thermostatic traps for low pressure steam runouts, down feed risers to unit heaters and for radiation and convectors.

3.6 STRAINERS

- A. Provide Y-type strainer ahead of each steam trap (except thermostatic trap), pressure reducing valve and control valve. Omit strainer where trap is serving coil with strainer ahead of control valve in steam supply to coil.

3.7 UNIONS AND FLANGES

- A. Provide flanged or screwed unions in connections to equipment and where shown on drawings.

3.8 FLEXIBLE CONNECTORS

- A. Provide flexible pipe connectors on pipes connected to vibration isolated equipment where shown. Do not allow weight of piping to be carried by equipment
- B. Install devices in accordance with manufacturer's recommendations.

3.9 FLEXIBLE EXPANSION LOOPS

- A. Provide piping passing through seismic, expansion, and construction joints. Anchor piping on both sides of joint so that building movement will not cause structural stress on piping supports.
- B. Install devices in accordance with manufacturer's recommendations.

3.10 EXPANSION JOINTS

- A. Use multiple flexible pipe connectors or manufactured seismic separation assemblies to achieve deflection capabilities specified above.
- B. Install devices in accordance with manufacturer's recommendations.

3.11 PIPE ALIGNMENT GUIDES

- A. Install guides as shown on drawings and where recommended by expansion joint manufacturer.
- B. Rigidly anchor pipe to building structure where necessary. Provide pipe guides so that movement takes place along axis of pipe only.

END OF SECTION

SECTION 23 23 00

REFRIGERANT PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all refrigeration piping, fittings, valves and specialties to interconnect units of equipment as shown on the drawings.

1.2 QUALITY ASSURANCE

- A. The Contractor for the refrigerant piping system shall be a qualified refrigerant piping contractor, regularly engaged in the installation of refrigerant piping systems.

1.3 REFERENCES

- A. ANSI/ARI 495 - Refrigerant Liquid Receivers
- B. ANSI/ARI 710 - Liquid Line Dryers
- C. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration
- D. ANSI/ASHRAE 34 - Number Designation of Refrigerants
- E. ANSI/ASME SEC 8D - Boilers and Pressure Vessels Code, Rules for construction of Pressure Vessels
- F. ANSI/ASME SEC 9 - Boilers and Pressure Vessels Code, Welding and Brazing Qualifications
- G. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
- H. ANSI/ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes
- I. ANSI/ASME B31.5 - Refrigeration Piping
- J. ANSI/ASME B31.9 - Building Services Piping
- K. ANSI/ASTM B32 - Solder Metal
- L. ANSI/ASTM B88 - Seamless Copper Water Tube
- M. ANSI/AWS A5.8 - Brazing Filler Metal
- N. ANSI/AWS D1.1 - Structural Welding Code, Steel
- O. ANSI/UL 429 - Electrically Operated Valves
- P. ARI 750 - Thermostatic Refrigerant Expansion Valves
- Q. ARI 760 - Solenoid Valves For Use With Volatile Refrigerants
- R. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

- S. ASTM A120 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated (Galvanized), Welded and Seamless, For Ordinary Uses
- T. ASTM A234 - Pipe Fittings Of Wrought Carbon Steel And Alloy Steel For Moderate And Elevated Temperatures
- U. ASTM B280 - Seamless Copper Tube For Air Conditioning And Refrigeration Field Service
- V. MIL-I-631C - (Construction At Solenoid Valve Coils)
- W. MIL-V-23450C - Valves, Expansion, Thermostatic, Refrigerant 12 and Refrigerant 22.

1.4 SUBMITTALS

- A. Submit shop drawings for valves and accessories.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Copper Tubing: Chase Copper and Brass, Revere Copper and Brass.
- B. Fittings: NIBCO 600 Series, Superior Valves and Fittings.
- C. Shutoff Valves: Henry, Mueller Brass, Superior Valves and Fittings.
- D. Specialties and Accessories: Alco, Sporlan.

2.2 COPPER TUBING

- A. All copper tubing above ground shall be Type "L" hard.
- B. ~~All copper tubing below ground shall be Type "K" soft.~~
- C. Copper tubing shall be refrigeration duty and shall be delivered to the job site dehydrated and capped by the manufacturer.

2.3 FITTINGS

- A. Solder fittings shall be forged or wrought copper and shall be in accordance with ANSI Standard B16.22.

2.4 MOISTURE AND LIQUID INDICATORS

- A. Indicators: Single or double port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum working pressure and maximum temperature as dictated by the system requirements for the application.

2.5 VALVES

- A. Diaphragm Packless Valves: UL listed, globe or angle pattern, forged brass body and connect, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for

maximum working pressure and maximum temperature as dictated by the system requirements for the application.

- B. Packed Angle Valves: Forges brass, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure and maximum temperature as dictated by the system requirements for the application.
- C. Packed Ball Valves: Two-piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure and maximum temperature as required by the system for this application.

2.6 STRAINERS

- A. Straight Line or Angle Line Type: Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of maximum working pressure as dictated by the system requirements for the application.
- B. Straight Line, Non-Cleanable Type: Steel shell, copper plates fittings, stainless steel wire screen, for maximum working pressure as dictated by the system requirements for the application.

2.7 CHECK VALVES

- A. Globe Type: Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum working pressure and maximum temperature as dictated by the system requirements for the application.
- B. Straight-Thru Type: Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure and maximum temperature as dictated by the system requirements for the application.

2.8 PRESSURE RELIEF VALVES

- A. Straight-Thru or Angle Type: Brass body and disc, neoprene sat, factory sealed and stamped with ASME UV and National Board Certification NB and selected to ANSI/ASHRAE 15.

2.9 FILTER DRIERS

- A. Replaceable Cartridge Angle Type: ANSI/ARI 710, UL listed, brass shell and bronze cap, perforated brass shell and molded desiccant filter core; for maximum working pressure as dictated by the system requirements for the application.
- B. Permanent Straight-Thru Type: ANSI/ARI 710, UL listed, steel shell with molded desiccant filter core, for maximum working pressure as dictated by the system requirements for the application.

2.10 EXPANSION VALVES

- A. Angle or Straight-Thru Type: Design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, adjustable or non-adjustable superheat setting, replaceable inlet

strainer, with non-replaceable or replaceable capillary tube and remote sensing bulb or remote bulb well.

- B. Selection: Evaluate refrigerant pressure drop-through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.11 RECEIVERS

- A. Internal Diameter 6 inch and Smaller; ANSI/ARI 495, UL listed, steel, brazed; 400 psi maximum pressure rating with tappings for inlet, outlet, and pressure relief valve.
- B. Internal Diameter over 6 inch: ANSI/ARI 495, welded steel, tested and stamped in accordance with Section 8D of the ASNI/ASME Boiler and Pressure Vessels Code: 400 psi with tappings for inlet, outlet and pressure relief valve.

2.12 FLEXIBLE CONNECTORS

- A. Corrugated [stainless steel] [bronze] hose with single layer of [stainless steel] exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure as dictated by the system requirements for the application.

PART 3 - EXECUTION

3.1 SEISMIC RESTRAINT

- A. Fabricate and support piping in accordance with specifications herein, and latest edition of CMC. Provide seismic restraint in accordance with a current OSHPD pre-approved system that carries a current OSHPD OPA Number. For seismic restraint, see Section 23 05 48.
- B. Install seismic separation assemblies at building seismic joints.

3.2 COPPER TUBING

- A. Handle copper tubing with care at all times. Keep stored in a dry place and do not open tubing to atmosphere until ready to use. Every attempt shall be made to keep it clean and dry.
- B. Connect soft copper tubing by flaring and even though concealed, it shall be installed in a neat workmanlike manner. Tubing shall be rolled out into a straight pattern and bent with tube benders of proper size.
- C. Fusing hard copper tubing to fittings shall be done with 95/5 solder, Stay-Brite silver bearing solder or Sil-Fos. Where 95/5 or Stay-Brite solders are used, contacting surfaces shall be sanded to a bright finish, fluxed and then soldered. Where Sil-Fos high temperature brazing is used, the brazing shall be done after purging air out of tubing with dry nitrogen and maintaining a nitrogen gas flow through pipe during brazing.
- D. Support piping in accordance with Section 23 05 10, "Supports, Anchors and Seals."
- E. Ream pipe and tube ends. Remove burrs.
- F. Remove scale and dirt on inside and outside before assembly.

- G. Prepare piping connections to equipment with flanges or unions.

3.3 FITTINGS

- A. Wire brush or sand solder fittings to a bright surface before fusing to copper tubing.

3.4 SHUTOFF VALVES

- A. Solder valves shall be disassembled before installation and shall be sanded or wire brushed before fusing. Special precautions may be necessary to keep from warping the valve body during high temperature brazing.
- B. Install valves where indicated on drawings or where required for general servicing.

3.5 INSTALLATION

- A. Contractor shall be responsible for designing the piping systems, including location of all valves, devices etc.
- B. Install refrigeration specialties in accordance with manufacturer's instructions.
- C. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- D. Install piping to conserve building space and not interfere with use of space.
- E. Group piping whenever practical at common elevations and locations. Slope piping one percent (1%) in direction of oil return.
- F. Provide non-conducting dielectric connections when joining dissimilar metals.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- H. Provide clearance for installation of insulation and access to valves and fittings.
- I. Provide access to concealed valves and fittings.
- J. Where pipe support members are welded to structural building frame, brush clean, and apply one (1) coat of zinc rich primer to welding.
- K. Prepare pipe, fittings, supports and accessories not prefinished, ready for finish painting.
- L. Insulate piping [and equipment]; refer to Section 23 07 10.
- M. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- N. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- O. Install flexible connectors at right angles to axial movement of compressor.
- P. Fully charge completed system with refrigerant after testing.
- ~~Q. Provide electrical connection to solenoid valves.~~

3.6 APPLICATION

- A. Provide line size liquid indicators in main liquid line leaving condenser, or if receiver is provided, in liquid line leaving receiver.
- B. Provide line size strainer upstream of each automatic valve. Where multiple expansion valves with integral strainers are used, install main liquid line strainer.
- C. On steel piping systems, provide strainer in suction line.
- D. Provide shut-off valve on each side of strainer.
- E. Provide permanent filter-driers in low temperature systems and systems utilizing hermetic compressors.
- F. Provide replaceable cartridge filter-driers vertically in liquid line adjacent to receivers with three-valve bypass assembly to permit isolation of driers for servicing.
- G. Provide replaceable cartridge filter-driers, with three-valve bypass assembly. Provide filter-driers for each solenoid valve.
- H. Provide solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems, and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.
- I. Provide refrigerant charging (packed angle) valve connections in liquid line between receiver shut-off valve and expansion valve.
- J. Utilize flexible connectors at or near compressors where within piping configuration does not absorb vibration.

3.7 CHECK, TEST AND START-UP

- A. Leak Test:
 - 1. Pressure test the refrigeration piping system with dry nitrogen to 200 psig. Test to no leakage.
 - 2. Leak test all joints and connections.
 - 3. If leaks are found, repair them and repeat the above until system is totally leak free.
 - 4. Before charging, evacuate entire system with a vacuum pump. Maintain operation of vacuum pump until pressure reaches 75 microns or less.
 - 5. When the proper vacuum has been reached, break vacuum with refrigerant to be used and build-up pressure to a positive pressure.
- B. Charging:
 - 1. When system has been leak tested and evacuated, charge it with refrigerant.
 - 2. Charge system until sight glass remains clear when all refrigeration is at maximum load condition.

C. Start-Up:

1. After charging system, check all phases of operation to see that everything is operating satisfactorily.

END OF SECTION

SECTION 23 25 00

HVAC WATER TREATMENT SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Water treatment equipment and chemicals for the initial cleaning and corrosion protection for the permanent water treatment of:
 - 1. Closed chilled water system.
 - 2. Closed hot water heating system.
 - 3. Steam system.

1.2 RELATED SECTIONS

- A. Section 23 05 00: Common Work Results for HVAC

1.3 DESCRIPTION OF WORK

- A. Extent of water treatment system work required by this section shall be a complete automated system with electronic monitoring capability, a complete chemical feed system that eliminates all handling of the chemicals by operation's personnel, on-site training and troubleshooting by chemical vendor's personnel and the necessary equipment, chemicals, and service to inhibit development of scale, corrosion and biological growth in the condenser water, closed loops and boiler systems.
- B. Service Period: Provide chemicals and service program for period of one year after Owner's acceptance of condensing equipment, including the following:
 - 1. Initial water analysis and recommendations.
 - 2. Systems start-up assistance.
 - 3. Training of operating personnel.
 - 4. Periodic field service and consultation.
 - 5. Customer report charts and log sheets.
 - 6. Laboratory technical assistance.
- C. Energy Management System (EMS) Interface:
 - 1. Control data communication protocol for the condenser water treatment shall be compatible to interface with the remote energy management system (EMS) that uses ANSI/ASHRAE Standard 135-1995, BACnet.
- D. Proposed Service Plan:
 - 1. Proposed service plan form shall be submitted along with the bid.

1.4 QUALITY ASSURANCE

- A. Codes and Standards:

1. UL and NEMA Compliance: Provide electrical components required as part of condenser water treatment equipment, which are UL-listed and labeled and comply with NEMA Standards.
 2. NEC Compliance: Comply with National Electrical Code as applicable to installation, electrical connections, and ancillary electrical components of condenser water treatment equipment.
 3. Chemical Standards: Provide only chemical products that are acceptable under State and local pollution control regulations.
 4. Prevention and treatment of the condenser water system Legionella infection shall meet the requirements listed in the guidelines by the State of California.
 5. California Mechanical Code.
- B. A single water treatment company shall be responsible for all products and services and shall be a recognized specialist in the field of water treatment. The water treatment company shall have access to water analysis laboratories and a technical service representative located within 30 miles of the job site.
- C. The water treatment company shall have a documented minimum of 5 years experience in the field of water treatment.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including the list of chemicals, chemical handling system or required handling, Material Safety Data sheets, consumption rates, rated capacities of selected equipment clearly indicated, water pressure drops, weights, installation and start-up instructions, and furnished specialties and accessories.
- B. Shop Drawings: Submit manufacturer assembly-type shop drawings indicating dimensions, weight loading, required clearances, and methods of assembly of components.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to water treatment equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring interfacing the Energy Management System (EMS). Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Maintenance Data: Submit maintenance data and parts list for each item of equipment, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Related Documents.

1.6 EXTENDED MAINTENANCE SERVICES

- A. Agreement to Maintain: Prior to time of final acceptance, submit 4 copies of "Agreement for Continued Service and Maintenance" for condenser water treatment system, for Owner's possible acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing, and including replacement of materials and equipment, for one-year period with option for renewal of Agreement by Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Water Treatment Supplies and Equipment: U.S. Water Services, Trident Technologies, Nalco, Aquatec or approved equal.
- B. Water Treatment Contractors: U.S. Water Services, Trident Technologies, Nalco, Trident Technologies, Aquatec or approved equal.
- C. Chemical Injection Pumps: Pulsatrol, LMI, Advantage or approved equal.
- D. Freeze Protection: Dow, U.S. Water Services Freeze Guard, Union Carbide.

2.2 CHEMICALS

- A. Cleaning Agent:
 - 1. Provide an alkaline/polymer/surfactant cleaner with passivating agents and corrosion inhibitors that will clean the new piping system of oil, mill scale and grease and provide corrosion protection in the liquid phase and the vapor phase.
 - 2. The cleaner shall leave residual protection such that the piping will be protected during the cleaning, testing, filling and during any period were the piping may be temporarily drained.
 - 3. Provide a cleaning agent with the follow components:
 - a. Alkaline
 - b. Emulsifier
 - c. Volatile Corrosion Inhibitor
 - d. Polymer Dispersant
 - e. Surfactant
 - f. Passivating Agent
- B. Chilled Water Systems:
 - 1. Provide a molybdate base corrosion inhibitor with polymer dispersants, corrosion inhibitors for both steel and copper. Maintain at least 50-ppm molybdate as Mo.
 - 2. Maintain system pH between 9.0 and 10.0.
 - 3. Provide dipslide field test kits. Perform dipslide test kit to culture biocides and measure the biological activity present in the system water.
 - 4. Provide a non-ionic biocide to be fed periodically as needed per bacteria dipslides performed once per month.
 - 5. Testing shall consist of a minimum of monthly on-site testing by a vendor's engineer to determine the pH, iron, copper, and molybdate corrosion inhibitor levels. Provide a one-year supply.
 - 6. Perform corrosion coupon studies every 90 days. Use mild steel and copper alloy for the test coupons. Corrosion coupon rack must have a consistent flow of 5 gpm.
- C. Hot Water Systems:
 - 1. Provide a Nitrite treatment for the prevention of scale and corrosion. Inhibitor shall have polymer dispersants to suspend any particulate and pH buffers to protect the system from corrosion.
 - 2. Maintain system pH between 9.0 and 10.0.

3. Provide dipslide field test kits. Perform dipslide test kit to culture biocides and measure the biological activity present in the system water.
4. Provide a non-ionic biocide to be feed periodically as needed per bacteria dipslides performed once per month.
5. Testing shall consist of a minimum of monthly on-site testing by a vendor's engineer to determine the conductivity, pH, iron and nitrite corrosion inhibitor.
6. Treatment level shall be maintained at over 750-ppm nitrite to protect the system from corrosion. Do not exceed 1,500 ppm nitrite. Provide a one-year supply.
7. Non-Oxidizing Biocide:
 - a. Provide a liquid non-ionic biocide to be added weekly to kill microbiological growth.
 - b. Biocide shall not interfere with the effectiveness of the scale inhibitor.
 - c. Biocide shall be effective on algae, anaerobic bacteria and capable of handling the pH of the operating system.
 - d. Biocides shall be EPA registered and meet State and local environmental regulations.
 - e. Non-Oxidizing Biocide shall be liquid and shall be delivered into a 30-gallon double contained chemical handling system by the vendor's delivery personnel. Provide adequate supply for one year from start-up date.
 - f. Provide dipslide field test kits. Perform dipslide test kit to culture biocides and measure the biological activity present in the system water.
 - g. Dipslides will be performed once per month, adjust biocide feed based on test results.

D. Performance: The following performance characteristics shall be met.

Closed Loop Systems

Corrosion Rate	-less than 1.0 mil per year mild steel -less than 0.1 mil per year copper -turbidity less than 50 NTU
Efficiency	-maintain condenser efficiency of 100% or starting -maintain full load KW/ton at design
Bacteriological	-less than 100,000 organisms/ml -negative Legionella counts -no anaerobic bacteria present -no visual algae of other biomass
Chemical Handling Training	-none except for wet boiler lay-up -meet 100% of planned events

2.3 EQUIPMENT

A. WATER TREATMENT CHEMICAL FEED PIPING (ABOVE GROUND)

1. Closed System ~~[Chilled Water]~~ and ~~[Heating Hot Water]~~ Pot Feeders:
 - a. Provide copper tubing unless otherwise indicated on Drawings.
 - b. Copper Tubing: ASTM B88, Type L, hard drawn.
 - c. Fittings: ANSI/ASME B16.23 cast brass, or ANSI/ASME B16.29 solder wrought copper.
 - d. Joints: ANSI/AWS A5.8, BCuP silver braze (95/5 solder).

B. BALL VALVES

1. PVC full port ball valves for chemical/water treatment systems where recommended by chemical feed supplier.

2.4 EQUIPMENT PERFORMANCE REQUIREMENTS

- A. General: Provide system sized and equipped to treat raw water available to project site to maintain the following condenser water characteristics:
 1. Provide maximum possible corrosion protection and prevent the formation of hard or soft deposits within the system. See performance specification in Section 2.2.
 2. Prevent the growth of algae, slime, Legionella infection and other microbial growth.
 3. Control the bleed rate to optimize the use of chemicals and makeup water while allowing good turnover of system water volume throughout the year.
 4. Provide a complete automated system with electronic monitoring capability that shall include operating logs and connection to the EMS system.

2.5 MATERIALS AND EQUIPMENT

- A. Make-up water meter shall be contacting head type or turbine "Hall Effect" type sized to the diameter of the make-up line with a totalizing register. Bleed water meter shall be contacting head or turbine "Hall Effect" type sized to the diameter of the bleed line with a totalizing register.
- B. Provide bleed valve assembly with 9 PSI differential solenoid valve (rated at 115 VAC), wye strainer and flow control valve sized to bleed water at maximum discharge rate based on tower tonnage and cycles of concentration.
- C. Provide liquid level sensor sized for the maximum liquid height and a PVC watertight enclosure to house sensor electronics.
- D. Provide secondary containment tanks for all products stored in a liquid form. Tanks shall have two (2) ¾" threaded inserts, one (1) 2" threaded insert, one (1) 4" removable cover and be made of ¼" polyethylene. Secondary tank shall have a capacity of 125% of the holding tank.
- E. Provide positive displacement diaphragm chemical feed pumps for inhibitor and biocide feed. Pumps shall be rated at 150 PSIG and have design capacity to meet the needs of the cooling system.
- F. Provide 3-station corrosion coupon rack with orifice to maintain water flow at a maximum of 5 gpm. Provide corrosion coupons to match system metallurgy.

2.6 CLOSED LOOP CHILLED WATER AND HEATING HOT WATER SYSTEM WATER TREATMENT

- A. Chemical Feeding Equipment
 1. Furnish and install a by-pass type pot feeder to feed chemical treatment into {hot water heating} and {chilled water} circulating systems.
 2. The by-pass pot feeder shall be installed on a 4-inch housekeeping pad.
 3. Feeder shall be 5 gallon size, and shall include a funnel, vent cock, drain cock and shutoff valves at inlet and outlet connections, a coupon rack, with a 5 gpm flow restrictor mounted on a backboard with isolation valves and be designed to meet the pressure requirements of the system.

4. The by-pass pot feeder shall be provided with legs to elevate the pot feeder above the housekeeping pad for access to the drain valve.
- B. Water Treatment Chemicals – Closed Loop Chilled and Hot Water Systems:
1. Furnish one-year's supply of the recommended formula for scale and corrosion protection of the closed recirculating system. Formulation shall not contain any ingredients, which are harmful to the system materials of construction.
- C. Testing Equipment:
1. Furnish water test equipment, including spare reagents for maintaining control of program standards in the water systems outlined above. Test equipment will include the following:
 - a. Reagents and apparatus for the determination of chemical levels in all water systems outlined above.
 - b. Reagents (molybdate, and nitrite) and apparatus for the determination of pH, alkalinity, chlorides, and hardness.
 - c. Conductivity meter with temperature compensation and multiple measurement ranges.

2.7 CHEMICAL HANDLING SYSTEM – SUPPLIERS RESPONSIBILITY

- A. The chemical supplier shall be responsible for delivering chemicals to the on-site locations of the chemical containment system. Supplier shall be responsible for providing the necessary pumps, piping and equipment necessary for the safe handling of all of the chemicals. Special provisions should be made for the chemical transfer into the chemical pot feeders without handling. There will be no chemical drums allowed to remain on-site. Modular chemical systems will be directly connected to the chemical pumps and the chemical pumps will directly pump the chemicals to the needed application point. The modular chemical systems shall be double contained with 125% containment.

2.8 TEST KITS

- A. Provide test kits to monitor the following parameters:
1. M Alkalinity
 2. Hardness
 3. Chloride
 4. Molybdate
 5. Bacteria level dip slides
 6. Myron L Conductivity Meter (0-5000 uS)
 7. Free halogen
 8. Sulfite (steam boilers)
 9. pH for condensate and boiler water.
- B. Provide test cabinet for storage of testing glassware and reagents. 18-gauge cold rolled steel cabinet, primed and painted white with extendable tray and fluorescent light.
- C. Provide one-year supply of spare test reagents.

2.9 SERVICE

- A. Provide consulting services for a period of one year from start-up of the cooling system which will include:
 - 1. Pre-operational system cleanout procedure supervision.
 - 2. Consulting and assistance with the cleaning and flushing process
 - 3. Start-up assistance to set up, prime and calibrate controllers and pumps.
 - 4. Initial water analysis and recommendations.
 - 5. Log sheets and record forms.
 - 6. Training of operating personnel on proper feeding and control techniques.
 - 7. Weekly service visits during the month of start-up.
 - 8. Training for operating personnel on equipment, chemical and testing.
 - 9. Monthly service during operating season.
 - 10. The water treatment contractor must provide annual testing for Legionella infection and microbial growth.
 - 11. Monitored the cooling tower periodically to inhibit zinc corrosion. Re-passivation may be necessary during normal operation.
 - 12. Required laboratory and technical assistance.

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which condenser water treatment systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF WATER TREATMENT SYSTEMS

- A. General: Install condenser water treatment system in accordance with all written installation instructions provided by the manufacturer. Install pressure gages, valves, and controls furnished by manufacturer, in accordance with manufacturer's instructions. The system shall include, but not limited to the following:
 - 1. Install an extra-heavy steel coupling in the circulating water line, welded at 30 degree to 45 degree angle with inboard end pointing in the direction of flow. Install two couplings when acid feed is being provided.
 - 2. Install a corporation stop and injection assembly in each steel coupling with the PVC injector tube inserted completely with discharge end at the center of the circulating water pipe. Corporation stop quill to be stainless steel.
 - 3. Provide a wall mounted shelf for the chemical pump, install the pump and connect pump discharge line to the injector check valve. Provide two pumps when acid feed is being provided.
 - 4. Install the water meter with three valve shut-off and by-pass.
 - 5. Install a bleed-off line with shutoff valve, solenoid valve, and control valve from the pump discharge line and discharge into an open funnel drain.

6. Install a system water line to the controller box inlet (pressure side of pump) and return lower pressure system line.
7. Install control cabinet on wall where shown on the drawings. A 120v/1Ph/60Hz electrical supply will be provided by Division ~~46-26~~ Contractor within 10 feet of the control cabinet, terminating in a fused disconnect. Include all electrical wiring from the disconnect to a control panel and all interconnecting components of the system, including interlock wiring between the control panel and a flow switch in the condenser water line to prevent operation when there is no flow; interlock wiring between the control panel and the water meter; interlock wiring between the control cabinet and the chemical pump; and interlock wiring between the control cabinet and the bleed-off solenoid. All interlock wiring shall be to a terminal block in the control cabinet.
8. Furnish and install a SPST flow switch in the condenser water line to prove flow before injection of chemicals.

B. ~~Chilled Water/~~ Hot Water Closed Loop Systems:

1. Mechanical Contractors responsibilities – Install by-pass feeders, including shut-off valves, bypass valves and drain. Install a sampling connection in the circulating water line including a 1/4 inch ball valve and an air vent at outlet of feeder.
2. Chemical Treatment Contractors responsibilities – Provide the initial cleaning and corrosion inhibitors as described in Section 2.

3.3 WATER TREATMENT SERVICE PROGRAM

- A. The supplier shall provide from qualified service representatives, 16 service visits, complete with reports at the following times:
1. Visit one: Aid on installation, identification of installation points for equipment, and outline of program with contractor.
 2. Visit two: Installation and inspection of water treatment systems.
 3. Visit three: Inspection and testing of cleaned and drained piping, scheduling tentative date for start-up.
 4. Visit four: Start-up and initial cleaning of system.
 5. Visit 5-16: Training of operators, and beginning monthly service visits to total 12 visits over one year of operation. Each call shall include testing all systems, checking chemicals and equipment and completing field test reports. Troubleshooting and training of new operators is always included.

3.4 PREOPERATIONAL SYSTEM CLEANOUT

- A. Flush out condenser, closed chilled, closed hot and boiler water systems and related piping with preoperational cleaning chemicals designed to remove construction deposits such as pipe dope, oils, loose mill scale, and other extraneous materials.
- B. Fill and flush piping systems, both open and closed, with a 0.25 solution, by weight, of a non-foaming chemical detergent, to remove foreign matter. After final filling, the pH of the water shall be a minimum 10.0. Condenser waters shall be cleaned with a neutral pH cleaner when galvanized surfaces are present in the cooling tower. Where necessary to provide for water circulation throughout systems, which are incomplete, install temporary valved bypasses. Clean/replace baskets after cleaning process is complete on strainers.
- C. Add recommended dosages of cleaner and recirculate for 6 to 8 hours. Drain and flush until total alkalinity of rinse water is equal to make-up water.

- D. Verify concentration of solutions in water via water chemistry.
- E. Refill with treated clean water. Maintain water turbidity below 50 NTU to remove deposition such as pipe dope, oils, loose rust and mill scale, and other extraneous materials.
- F. The recommended dosages of pre-cleaning chemical products shall be added to the system and circulated throughout the system. Verify concentrations using system volume calculations.
- G. Drain, fill and flush system until no foreign matter is observed and total alkalinity of the rinse water is equal to that of the makeup water.
- H. Work shall be completed and circulation shall have been established throughout systems and where water from these systems runs clean, free from deposits. The Contractor shall submit to the Architect a statement that each of the piping systems is cleaned and treated.

3.5 BY-PASS POT FEEDER

- A. The vendor shall install and maintain the corrosion coupons and perform the 90 day test.
- B. The coupons shall be installed prior to adding any water to the system; i.e. pressure test water and chemical cleaning.
- C. The mechanical contractor shall pipe the feeder drain to sanitary sewer.
- D. The installation of the corrosion coupon rack shall be separate from the supply and return piping for the bypass feeder, this results in erroneous coupon results.

3.6 START-UP

- A. After piping systems have been cleaned as described in this Section and 23 05 16, Hydronic Piping, treat systems with necessary chemicals to protect them from corrosion damage. Notify Owner in writing that this work has been completed and tested, with a copy to Engineer.
- ~~B. Start-up Procedures: During condenser cooling water system start-up, operate condenser water treatment system (after charging with specified chemicals) to maintain required steady-state characteristics of cooling water.~~
- ~~C-B. Cooling Tower Start-up: The interior of the cooling tower(s) shall be passivated and monitored periodically as part of the water treatment program. Coordinate with cooling tower supplier.~~

3.7 CHEMICALS

- A. After piping systems have been cleaned as described in this Section and 23 05 16, Hydronic Piping, treat systems with necessary chemicals to protect them from corrosion damage. Notify Owner in writing that this work has been completed and tested, with a copy to Engineer.
- B. Chemicals shall be acceptable to City and State PCA and shall not contain any chromates.
- C. Provide a one year's supply of condenser water treatment to inhibit the formation of scale, corrosion and algae, including the consulting services of a water treatment engineer during initial start-up and on monthly basis thereafter for the first year after start-up. Service shall begin when the owner receives the occupancy permit.

- D. Water Treatment Chemicals - Chilled Water and Hot Water Systems: Furnish one year's supply of the recommended formula for scale and corrosion protection for the closed recirculating system. Formulation shall not contain any ingredients that are harmful to system materials of construction. The water treatment contractor shall specify the control ranges, and the type of corrosion inhibitor that will be used.

~~3.8~~ ANTI-FREEZE SOLUTION

- ~~A. Furnish and install a sufficient quantity of anti-freeze fluid into the piping systems, where required, to provide a 40 percent glycol/60 percent water solution.~~
- ~~B. Thoroughly clean the piping systems before installing glycol fluid.~~
- ~~C. Use water with low levels (less than 50 ppm) of chloride, sulfate and hard water ions (Ca^{++} , Mg^{++}) for filling systems that will contain the water/glycol fluid solution.~~

~~3.93.8~~ TESTING

- A. Sample condenser cooling water at one-week intervals after condenser start-up for period of 4 weeks and prepare certified test report for each required water performance characteristic. Comply with the following standards, where applicable:
1. ASTM D859 – Test Methods for Silica in Water.
 2. ASTM D1067 – Test Methods for Acidity or Alkalinity of Water.
 3. ASTM D1068 – Test Methods for Iron in Water.
 4. ASTM D1126 – Test Methods for Hardness in Water.
 5. ASTM D3370 – Practices for Sampling Water.

~~3.103.9~~ TRAINING OF OWNER'S PERSONNEL

- A. Provide services of supplier's representative for one-day training seminar to instruct Owner's personnel in operation, maintenance, and testing procedures of condenser water treatment system.
- B. Post all OSHA and EPA regulations pertaining to each product used on the project site. Include all MSDS information for each chemical.
- C. Provide the Owner with an overall chemical system operations manual that provide training and direction on the various chemical applications.

END OF SECTION

SECTION 23 29 23

VARIABLE FREQUENCY CONTROLLERS (VFDs)

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide variable frequency drives (VFDs) as called for in these specifications and noted on the Drawings for controlling electric motor speeds.

~~1.2 RELATED SECTIONS~~

- ~~A. Section 23 05 00: General Provisions~~
- ~~B. Section 23 05 13: Motors and Drives~~
- ~~C. Section 23 21 23: HVAC Pumps~~
- ~~D. Section 23 73 23: Factory Assembled Air Handling Units~~
- ~~E. Section 23 34 16: Fans~~
- ~~F. Section 23 09 00: Building Control Systems~~
- ~~G. Section 23 09 19: Hydronic Flow Control Systems~~
- ~~H.B. Section 23 09 16: Air Flow Control Systems~~

~~1.3~~ 1.2 QUALITY ASSURANCE

- ~~A. Provide only Variable Frequency Drives suitable for application to NEMA Design B induction motors.~~ Provide drives compatible with standard production, 480 Volt, 3 phase high efficiency motors. Never purchase drives that require any modifications of the motor or any special motor design. Use only drives approved by Underwriters Laboratories or ETL as well as by the other regulatory agencies listed in this specification.
- B. No VFD on the Project shall produce line noise (power line voltage or current distortion) in excess of that defined in the IEEE Standard 519-1981. In part, this standard states that the voltage distortion factor shall not exceed 3%, and line notch depths shall not exceed 10%.
- C. Audible noise from any VFD operating anywhere in its range shall not exceed 85 dBA, measured at a point 3 feet from the VFD.
- D. Referenced Standards:
 - 1. Underwriters Laboratories
 - 2. UL 508
 - 3. National Electrical Manufacturer's Association (NEMA)
 - 4. ISC6, Enclosures for Industrial Controls and Systems
 - 5. IEC 801-2, 801-4, 255-4
 - 6. Institute of Electrical and Electronic Engineers (IEEE)
 - 7. Standard 519-1992 IEEE Guide for Harmonic Content and Control

1.41.3 SUBMITTALS

- A. Submit complete technical data sheets for each VFD showing all pertinent data including at least the following:
1. Connected motor nameplate full load amperage.
 2. VFD characteristics:
 - a. Motor amperage capacity. – If available.
 - b. Power factor at full load.
 - c. Efficiency at full load.
 - d. Electrical power input characteristics.
 - e. Control interface requirements.
 - f. Status display systems.
 - g. Physical dimensions and weight.
 - h. Options not listed in the specifications.
 - i. Exceptions and variations from the specifications.
 3. Compliance to IEEE 519 for the particular job site including total harmonic analysis for voltage and current.
 - 1) Provide calculations for job site showing total harmonic voltage distortion is 3% or less. Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 5519-1992. The acceptance of this calculation must be accepted prior to VFD installation.
 - 2) Prior to installation, the VFD manufacturer shall provide the estimated total harmonic distortion (THD) for voltage caused by the VFDs at the point of common coupling. The results based on a computer aided circuit simulation of the total actual system, with information obtained from the engineer and contract documents.
 - 3) If the voltage THD exceeds 3% the VFD manufacturer is to recommend/include the additional equipment required to reduce the voltage THD to an acceptable level.
 4. Submit complete wiring diagrams and dimensional drawings of all equipment including at least the following information:
 - a. Monitoring and control terminals, designations and locations.
 - b. Power circuit diagram, including the disconnect, [bypass] and motor.
 - c. Control circuit diagram.
 - d. Wiring of options and auxiliary devices.
 5. Submit certification of factory functional final testing
- B. Upon completion of the work, the Contractor shall include all the above information in his inserts for the Owner's Manual. The Contractor shall also include all information about operating, maintaining and ordering replacement parts for their VFDs.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Allen Bradley

- B. ABB
- C. Danfoss Graham
- D. Acceptance of a manufacturer's products does not release him from the requirements of the specifications. All suppliers listed above may submit their products, but each shall also submit a letter describing any part of these specifications he can not meet. If he has taken no exceptions to the specifications in his submittal, the supplier shall meet all requirements of the specifications.
- E. The Contractor shall obtain all the VFDs for the entire Project from a single manufacturer.

2.2 GENERAL REQUIREMENTS

- A. Provide each VFD as a solid-state electronic device consisting primarily of an input converter section (which converts AC power to DC power) electrically linked to an output inverter section (which produces output power to the motor with controllable frequency and voltage). Solid-state electronic devices packaged with the VFD shall perform all the necessary control functions that sense and control specific operating parameters and protect the motor and the drive. Speed control shall be continuous and stepless throughout the control range from 10% torque and RPM to the design operating conditions. Use only the best quality electronic devices operating well within their design operating ranges as components in these drives.
- B. Unless noted otherwise, provide only VFDs that will accept 460 Volt ($\pm 10\%$), 3 phase, 60 hertz power to produce a 3 phase output for positive motor speed and torque control. The output frequency and voltage shall track at a constant volts per hertz ratio over the entire operating range.
- C. Provide each VFD to meet or exceed the motor current stated in NEC 430-150 to serve the motor to which it is connected. Rate output for at least the motor nameplate full load amperage. Nevertheless, size VFDs equipped with an internal bypass to deliver starting current to their motors. Include a 115% service factor in the current rating for each VFD so the VFD can operate safely and continuously at 115% of its rated ampacity.
- D. Select VFDs so they are at least 95% efficient at 100% speed and at least 85% efficient at 50% speed. Provide each VFD with a power factor of at least 95% at 100% speed and at least 90% at 25% speed.
- E. Use only VFDs compatible with an environment maintained in a range between 0° C. and 40° C. with relative humidity up to 95% (assuming no condensation) at elevations up to 3,300 feet above sea level.
- F. Each VFD enclosure shall be NEMA 1.
- G. In accordance with applicable safety codes, all capacitor voltages within each VFD shall reduce to a safe value after power is disconnected.
- H. Each bidding supplier of VFDs shall review all the Contract Documents for Division 23 and 26 and shall become completely familiar with the power source(s) and transformers and with the nature of the loads on the Project's power distribution system. After this review, each VFD supplier shall verify that the equipment supplied will be compatible with the electrical distribution system and capable of continuous, stable operation. They shall also verify that the equipment will be capable of starting and stopping while connected to the electrical system under any anticipated operating condition. VFD operation shall not cause any malfunction or interaction with any other loads or devices connected to the electrical system. Conversely, no VFD operation shall be adversely affected by any other loads or VFD operations.

- I. Select VFDs carefully so harmonics produced by all the VFDs in the facility, combined, do not exceed the following limits:
 1. 3% total harmonic voltage distortion.
 2. Line notching of one (1) zero crossing per cycle.
 3. Where required to meet the harmonics requirements listed above, furnish and install UL listed, dry-type, isolation transformers or line reactors or harmonic filters to attenuate the affect of the VFDs upon the rest of the electrical system. Isolation transformers shall comply with ~~Section 16460 — Transformers~~ Div 26, and shall have a UL rating of K-13.

2.3 CONVERTER SECTIONS

- A. Provide an input converter based upon a full wave diode bridge design. Provide an isolation transformer or a line reactance on the incoming power supply. The isolation transformer or line reactors shall provide a minimum of 3 % line reactance. Drives with internal line reactance or internal chokes that provide for the equivalent of 3 % line reactance are considered acceptable.

2.4 INVERTOR SECTION

- A. Provide an inverter section that is solid state, with Pulse Width Modulated (PWM) output waveform. Six step and current source drives are not acceptable.

2.5 CONTROL SECTION

- A. Electrically isolate the following circuit systems from the main power circuits:
 1. The internal control circuitry used to regulate the DC bus voltage and invertor output frequency.
 2. The circuitry that supplies the various microprocessors, controllers, sensors, etc., to provide the drive's operational and safety features.
- B. Provide devices to limit operational parameters including at least the following:
 1. Devices to permit field adjustment of the minimum output frequency. The range shall go from a 4 Hz minimum to a 60 Hz maximum.
 2. Devices to permit field adjustment of the maximum output frequency. The range shall go from a 4 Hz minimum to a 60 Hz maximum.
 3. Devices to permit individual field adjustment of the acceleration rate from 0% to 100% speed in from 2 to at least 120 seconds. Unless noted otherwise, set full range acceleration rates initially at 60 seconds.
 4. Devices to permit individual field adjustment of the deceleration rate from 0% to 100% speed in from 2 to at least 120 seconds. Unless noted otherwise, set full range deceleration rates initially at 60 seconds.
 5. Devices to permit field input of at least two output frequency ranges that will be locked out for the VFD. These controls shall allow the VFD to accelerate or decelerate through these rages, but shall not allow it to operate constantly within them.
 6. Devices to permit field adjustment of the maximum output current limit to at least 115% of the invertor ampacity. Unless noted otherwise, set current limits initially at 100% of the invertor ampacity.

7. Devices to permit adjustment of the volts per hertz ratio which shall be factory set and sealed at a value equal to the drive's rated voltage divided by 60 Hz. The adjustment range shall encompass the range 7.6 V/Hz \pm 50% (460 volt) or 3.5V/Hz \pm 50% (208 volt) as well as V/Hz squared.
8. A field adjustable output carrier frequency range of 1 kHz to 12 kHz, factory set at 3 kHz. This allows field adjustment to compensate for motor noise. Using higher frequencies causes a greater stress to be placed on the motor due to the increase of reflected wave applied to the motor. VFD shall be fully rated for rated HP at all carrier frequencies. ~~No derating will be allowed. If acoustical motor noise created by the VFD is deemed objectionable by the engineer, the VFD supplier shall remedy the situation at no cost to the project or engineer.~~

C. Provide at least the following protection controls:

1. Input AC circuit breaker or disconnect with fuses and a lockable handle.
2. Protection from transients and surges in either voltage or current on the input line.
3. Input line, non-momentary, under-voltage self-protection of 5% and over-voltage self-protection of 10% of the rated operating voltage. Over-voltage protection shall protect against input line over-voltage and excessive regenerative energy from the motor and the load. The VFD shall ride through momentary power outages of up to 5 cycles (83 milliseconds).
4. Over-temperature protection of the VFD solid-state devices. These devices shall sense temperatures and shut down the drive when temperatures exceed the manufacturer's rated temperature limits.
5. Running over-current protection to keep the VFD operating within the limits established for the various types of motors specified in Section 23 05 13. These current limiting devices shall function automatically to prevent an over-current trip due to a momentary overload condition.
6. An automatic reset and restart circuit that will restart the motor 20 seconds after a self-protection shut down. The VFD shall attempt 5 automatic restarts. Each successive attempt shall occur at least 2 minutes after the last.
7. Protection against damage caused when the VFD attempts to start a motor that is already rotating. Provide this protection only for VFDs that can not start a rotating motor.

D. The following list of required VFD operating controls is a generic list that applies to all VFDs provided on the Project. In additional, certain applications (such as variable speed pumping) may require their own unique operating controls. Refer to the separate Sections of the Specification for the operating controls unique to each application. Provide at least the following operating controls with each VFD used on this Project:

1. An all-electric, solid-state operating control system that shall cause the inverter section output frequency and voltage to modulate in response to signals generated by the Sequence of Operation specified in Section 15985. The output frequency shall be accurate to within 3 Hz and stable to within \pm 0.5% of the setting. The output voltage shall be stable to within \pm 2% of the setting. The output frequency control shall respond to any of the following control signals:
 - a. Potentiometers: 6000 Ohm and 135 Ohm.
 - b. Direct Current Analog Voltages (VDC): 0 - 10 VDC and 0 - 5 VDC.
 - c. Direct Current Analog Milliamps (ma): 4 - 20 ma and 0-5 ma.
 - d. Direct digital network serial communication capability.
 - e. Controls shall be scalable as needed.

- f. Inputs shall be grounded or floating as needed.
2. Any VFD shall respond to any of the above signals in either a direct or a reverse mode of operation. Refer to Section and the Equipment Schedule for the required interface in each case.
3. Any VFD shall provide an analog output signal (VDC) proportional to either output frequency, volts or amps. The controls on the VFD shall allow a manual selection of the type of output signal. They shall also provide a field adjustment of the range of this signal from 0 to 1 through 0 to 10 VDC.
4. Equip each VFD with a built-in self-diagnostic section that indicates at least the following:
 - a. Control power supply failure.
 - b. Short circuit or ground fault.
 - c. Open circuit.
 - d. The presence of logic gate pulses for both the inverter and the converter sections.
5. The VFD control system shall start and stop the motor in response to any of the following:
 - a. A contact closure.
 - b. The speed control signal dropping below or rising above a minimum setting.
6. Provide the following monitoring switches rated for at least 1 amp at 120 VAC:
 - a. Run Contact - toggles when the motor is started or stopped.
 - b. Trip Contact - toggles when a protective circuit shuts down the unit. The trip contact shall signal continuously until it is manually reset, even if the unit automatically restarts.
7. To facilitate testing and troubleshooting, provide invertors and controls capable of operating without a motor or load of any kind. This stand-alone operation allows monitoring of the inverter response to all control signals without affecting the motor or the driven equipment.
8. Provide a cabinet and other enclosures for each VFD that include at least the following:
 - a. Either a wall mounted or a free standing NEMA 1 enclosure(s) shall house the converter, inverter, inductors, capacitors, control transformer and PC boards, relays, fuses, motor overloads, electric sensing devices and contactors.
 - b. Provide an electrical input disconnect switch between the controller and all phases of incoming electrical power. Include a through-the-door interlocking handle with provisions for padlocking.
 - c. ~~For AH-20, AH-21 and AH-23, provide a separate, manual bypass section containing a starter and all bypass wiring, contactors, relays and motor protection equipment so they are isolated from the solid-state VFD. This separate bypass shall permit maintenance of the VFD internals under zero power conditions with the motor running at full speed in isolated bypass.~~
9. Miscellaneous Devices
 - a. Provide three-leg motor overload protection for each motor connected to the inverter section output. Size and install this protection in conformance with the NEC.
10. The following devices shall be door mounted:
 - a. Displays – Plain English Readout Only.
 - 1) Six digit, elapsed time meter indicating system run time.

- 2) Ammeter displaying input current, or KW meter displaying input power (True RMS Values).
- 3) Meter displaying output frequency.
- b. Indicators
 - 1) "On/Off" Status.
 - 2) Input power status.
 - 3) Input power fault.
 - 4) Over-current fault.
 - 5) Over-voltage or under-voltage fault.
 - 6) Ground fault.
 - 7) Over-temperature fault.
 - 8) Motor overload fault.
- c. Manual Controls
 - 1) Hand-Off-Auto" selector switch for control system selection.
 - 2) Manual speed potentiometer calibrated in % maximum speed.
 - 3) Calibrated adjustment of current limit for fault protection.

PART 3 - EXECUTION

3.1 COORDINATION

- A. The VFD manufacturer shall provide a control interface that will accept input from a standard control interface. The manufacturer shall coordinate with the temperature control contractor to provide signal compatibility. Direct serial communication is preferable. ~~Common systems for interface include:~~
 1. ~~Siemens Technology Controls~~
- B. The VFD manufacturer shall coordinate with the driven equipment manufacturer to obtain information about any critical speeds, which must be locked out in the VFD controls to avoid problems with noise or vibration caused by harmonic resonance in mechanical systems.
- ~~C. Electrical Contractor shall coordinate final location of VFD with Manufacturer and Mechanical Contractor.~~
- ~~D.C.~~ Drive should be located as close as practical to the motor. If the location cannot be maintained within the manufacturers guidelines, manufacturer shall provide an output filter to minimize the effects of reflected wave considerations for the motor. The drive supplier shall coordinate the distance and location of the VFD with the contractor and shall include any required output filtering required with no additional cost to the project.

3.2 TESTING AND STARTUP

1. Startup and Acceptance Tests:
 - a. Factory trained personnel shall participate and advise in the initial startup of all systems connected to a VFD. In cooperation with the Mechanical Contractor, they shall perform the tests listed below. Arrange the tests with the Engineer and the Mechanical Contractor. Perform them at no additional cost to the Project.
 - b. Perform at least the following field operation tests and write a report to the Engineer that each VFD met the stated guidelines.
 - 1) Minimum output frequency = 4 hz \pm 1 hz.

- 2) Maximum output frequency = 60 hz \pm 1 hz.
- 3) Acceleration rate from dead stop to full speed tested at the maximum and the minimum rate adjustment.
- 4) Deceleration rate from full speed to dead stop tested at the maximum and the minimum rate adjustment.
- 5) Control signal setpoint \pm 10% of that specified.
- 6) Control setpoint offset \pm 10% of that specified.
- 7) Simulated power outage and control system reaction.
- 8) Manual bypass switchover tested. If so equipped.
- 9) Attempt starting into a rotating load to determine if self protection is adequate.
- 10) Test the installation to determine that the voltage distortion factor does not exceed 3% and the line notch depth does not exceed 10% as defined in IEEE Standard 519-1981 "IEEE Guide for Harmonic Control and Reactive Compensation of Static Power Converter." Provide the necessary line reactors to achieve these values. Provide a written report to the engineer showing all test results.

3.3 INSTALLATION

- A. Fasten cabinets and enclosures permanently to the building structure.
- B. Coordinate control connections with other contractors.
- C. All internal wiring should be factory connected. The VFD supplier shall install all wiring between each VFD enclosure and verify that all internal wiring is complete.
- D. Provide all power connections, including all power wiring associated with any isolation transformers disconnect switches, and accessories. Include power wiring from drive to motor. Ground condition.
- E. The temperature control contractor shall provide all control connections from outside sensors or from control devices.
- F. Install each VFD in sight of the motor it controls. If this is not possible, provide an auxiliary disconnect switch at the motor as required by the NEC or as required elsewhere in the specifications. If this becomes necessary, the Contractor shall notify the Engineer before proceeding.
- G. Provide a separate grounding conductor to the drive and from the drive to the motor in addition to and to supplement the conduit system. Ensure that the ground path is continuous to the building source of supply.
- H. Ensure that any motor overload protection is properly set, sized or programmed for the motor nameplate current of the motor, which it served, by the VFD. In the case of multiple motors being supplied from one VFD, provide separate overload protection for each motor.
- I. Provide separate metallic conduit for line, load and control conductors.

- J. Insure that rotation is correct in both normal mode of operation and in the bypass mode if the VFD is so equipped.

3.4 TRAINING

- A. The manufacturer shall arrange for and conduct a user training session at the Project site to explain the operation of each type of factory assembled VFD package. Allow at least eight (8) hours for the first drive, then four (4) hours for each drive beyond the first up to a maximum of twenty-four (24) hours for all installed drives. The supplier shall schedule the training sessions with the Owner and advise the Engineer of all such arrangements.

END OF SECTION

SECTION 23 31 10

DUCTWORK

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Ductwork
- B. Duct joints
- C. Flexible ductwork
- D. Laboratory exhaust ductwork
- E. Duct leakage testing set up and repair.

1.2 REFERENCE STANDARDS

- A. ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers).
- B. ICBO (International Conference of Building Officials).
- C. NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- D. SMACNA (Sheet Metal and Air Conditioning Contractors National Association).
- E. UL 181, Factory Made Air Ducts and Connectors.
- F. Applicable State and Local Codes.

1.3 DEFINITIONS

- A. Ductwork Dimensions: Duct dimensions shown on drawings indicate net free area. If ducts are lined, increase overall dimensions of the actual duct to accommodate the duct lining specified in Section 23 07 10, Mechanical Insulation.

1.4 CONSTRUCTION REQUIREMENTS

- A. Construct rectangular, round and flat oval ductwork, plenums and casings to accommodate pressure requirements of the air systems with metal gages, reinforcement and joints provided in accordance with standard industry practice, the latest SMACNA Standards, State and Local Codes, and the requirements of these Specifications.
- B. Subject to approval by governing authorities, transverse duct joints made with Ductmate 35 and 25 System joints, equivalent to SMACNA "J" and "F" connections, will be acceptable.
- C. Galvanized ductwork shall be constructed of lock-forming quality G-90 galvanized steel. All sheet steel shall be new.
- D. Steel Ducts: ASTM A525 or ASTM A527 galvanized steel sheet, lock-forming quality, having zinc coating of 1.25 ounces per square foot for each side in conformance with ASTM A90.

- E. Aluminum Ducts: ANSI/ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.
- F. Stainless Steel Ducts: ASTM A167, Type 316.

1.5 SUBMITTALS

- A. In addition to shop drawings for construction methods, material and equipment, submit ~~large scale~~ **electronic** (1/4" = 1'-0" minimum) ductwork layout drawings for review. Layout drawings shall include all supply, return, transfer and exhaust ductwork in sufficient detail for review of location and elevations of the ductwork. Drafting of the layout drawings shall be performed by the Contractor or under his direct supervision. The Engineer's drawings shall not be electronically or mechanically copied, including photocopying, for use as layout drawings unless permission is granted by the Engineer in writing.
- B. Submit results of duct leakage test.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Flexible Ductwork: Thermaflex M-KE, Flex-Aire MFS, Flexmaster 3M, Norflex NT-25M or approved equal.
- B. Special Duct Joints: Ductmate, TDC, Ward.
- C. Laboratory Exhaust Ductwork:
 - 1. ~~Polyvinyl Coated Steel: PVS Manufacturing Division, Midwest Spiro, Norlock, PCD, Wheeling.~~
 - 2.1. **Fiberglass: ATS. Welded stainless steel.**
- D. ~~Purchased,~~ Double Wall, Round and Flat Oval Ducts: United McGill, Semco or approved equal.
- E. ~~Purchased,~~ Single Wall, Round and Flat Oval Ducts: United McGill, Semco, Midwest Spiro or approved equal.

2.2 SHEET METAL GAGES (ALL SIDES)

- A. The following duct gages shall be minimums, regardless of the reinforcing schedule used, or if the ducts are cross broken or beaded.

- B. Rectangular, up to and including 2 inches water column:

Dimension of Longest Side	Steel Gage, USS	Aluminum Thickness (Gage)	Copper oz/sqft
0" - 12"	26	0.020" (24)	16
13" - 30"	24	0.025" (22)	24
31" - 54"	22	0.032" (20)	32
55" - 84"	20	0.040" (18)	36
Over 84"	18	0.050" (16)	48

- C. Rectangular, greater than 2 inches: duct wall thicknesses two gages heavier than shown in table for up to and including 2 inches water column, except that 18 gage is allowable over 84 inches.

- D. Round and flat oval, up to and including 2 inches water column:

Inches Duct Diameter	Galvanized sheet gage, USS		Aluminum Thickness (Gage)
	Round	Flat-Oval	
0" - 9"	26	24	0.020" (24)
10" - 14"	26	24	0.020" (24)
15" - 23"	24	22	0.025" (22)
24" - 37"	22	20	0.032" (20)
38" - 51"	20	18	0.040" (18)
52" - 61"	18	16	0.050" (16)
62" - 84"	16	14	14

- E. Round and flat oval, greater than 2 inches water column and up to 10 inches water column:

Inches Duct Diameter	Galvanized sheet gage, USS		Welded Fittings
	Spiral Lock Seam Duct	Longitudinal Seam Duct	
0" - 9"	26	24	22
10" - 14"	24	22	20
15" - 23"	24	22	20
24" - 37"	22	20	20
38" - 51"	20	20	18
52" - 61"	--	18	18
61" - 84"	--	16	16

- F. The above listed gages are minimums to be used on this project. Refer to applicable codes and standards for additional requirements.
- G. For ductwork crossing through a rated corridor without opening to corridor, the ductwork must be a minimum of 24 gage.
- H. Use galvanized steel schedule for polyvinyl coated steel or stainless steel.
- I. Provide 18 gage discharge and suction ductwork on air handling units to the first elbow, but a minimum of thirty (30) feet from the supply fan discharge and return fan inlet.

2.3 FLEXIBLE DUCTWORK

- A. Equal to Thermaflex M-KE air duct complying with UL Standard 181 as a Class 1 flexible air duct and NFPA Standards 90A and 90B. Ducts shall be composed of a CPE liner duct permanently bonded to a coated steel wire helix and supporting a fiberglass insulating blanket. Outer layer of low permeability vapor barrier of fiberglass reinforced film laminate. R value of 4.2, positive pressure rating of 6 inches water column, negative pressure rating of 1 inch water column. Maximum flame spread rating of 25, maximum smoke developed rating of 50.

2.4 SPECIAL DUCT JOINTS

- A. Air systems with the largest perimeter duct dimension greater than 18 inches which are required by these specifications to be constructed to SMACNA Seal Class "A" or "B" shall utilize transverse duct joints made with the Ductmate System or equal system of approved

manufacturer, installed in accordance with manufacturer's recommendations. This shall include using Ductmate angles, with integral polymer seal, tape gasket between mating flanges, secured by bolts and cleats applied around perimeter of the joints. The result shall be a zero leakage joint, as claimed by the manufacturer. If Contractor can provide equivalent results with alternate joining methods, he shall submit the proposed methods to the Engineer for his review and consideration. If no such proposal is submitted, joints shall be made as described above.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Fabricate and support ductwork in accordance with specifications herein, and latest edition of CMC. Provide seismic restraint in accordance with a current OSHPD pre-approved system that carries a current OSHPD OPA Number. For seismic restraint, see Section 23 05 48.
- B. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- C. Construct all sides, including bottom and top of all ducts and plenums, of sheet metal. No portion of the building construction, such as walls or slabs, shall be used as part of any duct or plenum unless called for on drawings or otherwise specified.
- D. Where width of duct exceeds 18 inches and is 22 gage or lighter, cross break or provide beads for rigidity, regardless of whether or not ductwork is lined or externally insulated. Open corners are not acceptable.
- E. Lap metal ducts in direction of air flow. Hammer down edges of slips and drives with duct mastic in the corners to leave a smooth duct interior and a tight fitting corner.
- F. All elbows shall be made with an inside radius of the same dimension as the width of the duct where space permits unless otherwise shown on the drawings. If the available space is not large enough for this type of elbow, the inside radius may be reduced to 1/2 the width of the duct. No elbows will be permitted which are constructed with an inside radius less than 1/2 the width of the duct unless turning vanes are used. If a take-off to a diffuser, register or flexible duct is 5 (five) feet or less from an elbow, the elbow must be a square elbow with turning vanes.
- G. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Maximum divergence upstream of equipment shall be 30 degrees and maximum convergence downstream shall be 45 degrees.
- H. Rigidly construct ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breathe, rattle, vibrate, or sag. Caulk duct joints and connections with sealant as ducts are being assembled.
- I. Where ductwork penetrates walls or floors of mechanical rooms, "hand stuff" space between opening and duct with glasswool, then fill edges with minimum 1/2 inch depth of sealing compound as described in Section 23 05 10, Supports, Anchors and Seals. Perform same

sealing operation where ducts pass through partitions and floors and elsewhere where sound transmission could be a problem.

- J. Install ductwork as high as possible to maintain proper headroom. Whenever possible, ducts shall be run close to beams or floor slabs above. Where ducts cross each other, they must be arranged in such a manner so as to maintain greatest possible clearance underneath. Do not cover any electrical outlets. Consult with other trades to avoid interference with piping runs or other obstructions. Inform Engineer before proceeding with any concealed ductwork that will require a ceiling to be lowered or shaft to be increased in size. Should it be found impractical to install any duct of exact sizes given, a duct of different shape but having same resistance shall be installed.
- K. Make all tee connections with a radius tap-in unless noted otherwise. Increase the duct connection for a rectangular branch duct to a rectangular main duct in general by 1/4 the width of the duct. This increase shall be a minimum of 4 inches. Taper the main duct connection at a 45 degree angle away from the main duct in the direction of air flow.
- L. Round branch connections to rectangular mains shall be made with conical, bellmouth or flared spin-in fittings. Straight connection fittings are not acceptable.
- M. Where it is necessary for a pipe or other obstruction to pass through a duct, install a streamlined sheet metal sleeve around the obstruction, soldered to the duct to make it air tight. Increase the cross section of the duct at such locations so that air velocity at the obstruction will not be increased. Inform the Engineer before proceeding with any such sleeves.
- N. Where coils are not made to slip within ducts, support them individually. Make connections to and around coils air tight.
- O. Coordinate location of duct access panels and equipment access doors so that wall or ceiling access doors correspond with duct panel and service locations for valves, dampers and other units.
- P. Provide ductwork transitions to duct-mounted equipment including filter housings, coils, sound attenuators, etc. Provide flanges.
- Q. Provide a cleanout at the bottom of each duct riser.
- R. Under no conditions are duct hangers to be secured to metal roof decking.
- S. Use double nuts and lock washers on threaded rod supports.
- T. Refer to Section 23 05 10, Supports, Anchors and Seals, for duct support information.
- U. The plenum serving the floor supply and return grilles shall be constructed as indicated on the drawings. The interior of all return and supply plenum serving the floor grilles shall be coated with bitumastic coating.

3.2 DUCT SYSTEM PRESSURE CLASSES

- A. Where duct construction pressure class is not designated on the drawings, the following requirements shall apply (except for sealing, which is addressed in another article):
 - 1. Unless noted otherwise, the pressure class of the ductwork for construction purposes shall be at minimum the external pressure rating of the air moving device for the entire length of the ductwork system.

3.3 SEALING DUCTS

- A. Seal all ductwork connected to air moving devices as described below.
 - 1. SMACNA Seal Class "A":
 - a. Entire ductwork systems where the fan is rated at 6 inches water column or greater external static pressure unless noted otherwise.
 - b. All Variable Air Volume (VAVCAV) systems from the fan discharge to the inlet of the VAVCAV box, regardless of the pressure rating of the fan. Ductwork downstream of the VAVCAV box shall be sealed in accordance with SMACNA Seal Class "C" or better.
 - c. Duct systems with booster coils, from the fan discharge to the inlet of the booster coil, regardless of pressure rating of the fan. Ductwork downstream of the booster coil shall be sealed in accordance with SMACNA Seal Class "C" or better.
 - d. Portions of ductwork enclosed in shafts or above inaccessible ceilings where the fan is rated at 1 inch water column or greater external static pressure.
 - 2. SMACNA Seal Class "B":
 - a. Entire ductwork systems where the fan is rated at from 1 inch water column up to 2 inches water column static pressure unless noted otherwise.
 - b. Portions of ductwork enclosed in shafts or above inaccessible ceilings where the fan is rated less than 1 inch water column external static pressure.
 - 3. SMACNA Seal Class "C":
 - a. Entire ductwork systems where the fan is rated at less than 1 inch water column external static pressure unless noted otherwise.
 - 4. No sealing required for the following ductwork:
 - a. Gravity transfer ducts.
 - b. Ductwork used to exhaust air from conference rooms into ceiling plenums.
 - c. Ductwork used to introduce or exhaust air from telephone or electrical closets.
- B. Above requirements apply to positive and negative duct pressures.
- C. Refer to Article in Part 2 entitled "Special Duct Joints" for additional requirements.

3.4 DUCT LEAKAGE TESTING

- A. Set up duct systems for duct leakage testing. The actual test is specified under Section 23 05 93. Set up shall include:
 - 1. Sealing duct openings upstream of air volume terminals/reheat coils, outdoor air openings and relief air openings. Seal ductwork openings.
 - 2. Provide openings for test contractor to connect flexible tubing.
- B. Take corrective action for system if system fails test. Pay for multiple re-tests until system passes the test.

3.5 FLEXIBLE DUCTS

- A. Where ceilings are not accessible, such as plaster ceilings or soffit areas, connections to air supply devices shall be made with rigid ducts. Flexible duct connections are not acceptable at these locations.

- B. Connect diffusers or light troffer boots to low pressure ducts with flexible duct, maximum of 3'-0" long.
- C. Properly cut flexible ductwork to length to avoid unnecessary bends in the duct. Do not use flexible ducts to change direction.
- D. Support flexible ductwork properly to avoid sags in the duct. Hangers shall be minimum of 2 inches wide to support at least two turns of the wire frame of the duct.
- E. Make connections with worm gear clamp or nylon or fiberglass banding and provide additional sealing as necessary to ensure that each joint is air tight.

3.6 LABORATORY EXHAUST DUCTWORK

- A. Applies to the following systems: Flammable storage/lab hoods/IV prep ~~EF-2, 4 & 6.~~
- B. Entire length of exhaust ductwork shall be constructed of stainless steel materials and shall be welded.
- C. ~~As a minimum, stainless steel ductwork shall be welded where located in shafts, over inaccessible ceilings, and from the discharge of the exhaust fan to where the duct connects to the double wall pressure stack specified under Section, Breeching, Chimneys and Stacks. Provide a gasketed, flanged connection to the exhaust fan.~~
- D. Exhaust ducts from flammable storage room and cabinets, acid storage cabinets, and base storage cabinets shall be 316L stainless steel ~~from the cabinet to where the duct connects to a manifolded exhaust main or the exhaust fan. Where rooms or cabinets are exhausted individually, the entire length of exhaust ductwork shall be stainless steel.~~ Connections from storage cabinets located under fume hoods are to be made at the top of the fume hood. Ductwork from the cabinet to the top of the fume hood will be by the laboratory equipment supplier.
- E. ~~Exhaust ductwork can be of galvanized construction except as noted otherwise. Ductwork located in shafts or above inaccessible ceilings shall be constructed of welded stainless steel. Ductwork from exhausted piece of equipment (such as fume hood) to the manifolded exhaust main shall be of stainless steel construction. Ductwork located on the discharge side of exhaust fans shall be welded stainless steel for the entire length to where the duct connects to the double wall pressure stack specified under Section 23-51-13, Breeching, Chimneys and Stacks. Provide a gasketed, flanged connection to the exhaust fan.~~

3.7 DUCTS ENTERING OR LEAVING BUILDING

- A. Outside air, exhaust air, or relief air ducts entering or leaving the building and passing over finished ceilings or future finished spaces shall be ~~soldered~~ sealed absolutely watertight for a horizontal distance of fifteen (15) feet from the wall or roof opening. Sealant equal to H. B. Fuller Resiweld No. 600 may be used in lieu of soldering.

3.8 CLEANING OF NEW DUCT SYSTEMS

- A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment, which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

- B. Clean duct systems with high power vacuum machines. Protect equipment, which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

END OF SECTION

SECTION 23 32 13

OUTDOOR AIR ~~PLENUM PANELS AND BUILT-UP AIR HANDLING UNITS~~

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials and equipment required for the complete construction of ~~built-up air handling units~~ outdoor air plenums described in this Section and shown on the Drawings.
- ~~B. Provide all labor, materials and equipment required for the complete construction of double wall ducts described in this Section and shown on the Drawings.~~
- ~~C-B. Furnish and install all items listed in this Specification, and locate them as indicated on Drawings.~~

1.2 REFERENCE STANDARDS

- A. ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers).
- B. ASTM (American Standards for Testing and Materials).
- C. NFPA (National Fire Protection Association).
- D. SMACNA (Sheet Metal and Air conditioning Contractors National Association).
- E. UL (Underwriter's Laboratories).

1.3 SUBMITTALS

- A. Submit shop drawings for all products provided under this Section. Include in the shop drawings data on acoustical and thermal performance.
- B. Submit proposed substitutions for the base specification with acoustical and thermal performance characteristics and with a complete description of all the components of the proposed system. Compare the proposed system to the description of the systems included in this Specification. List any differences between the proposed system and the Specification.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Double Wall Panels: United Sheet Metal Uni-housings, Rink, Semco or approved equal.

2.2 TYPE AND PERFORMANCE

- A. Fabricate, assemble and install plenum panels & walls as indicated on plans.

2.3 HOUSINGS

- A. Construct plenum panels or walls from at least (2) inch thick, double-walled sheet metal panels. The outer wall of each panel shall be at least 22 gage galvanized steel, unless the housings are higher than 10'-0". Housing panels higher than 10'-0" shall be at least 20 gage galvanized steel. Line the panels with 3-pound density fiberglass insulation that will not settle, shed or dust. Set walls in at least 4 inch high channels that are caulked to prevent water or air leakage. Provide reinforcing angles and other construction details in accordance with SMACNA Standards.
- B. Condensation: Substantiate condensate control claims with data submitted with the shop drawings.
1. ~~AHU Housing Panels: Construct AHU housing panels in a manner to prevent condensation with operating conditions equal to the ASHRAE summer outdoor design conditions outside the housing and with 50° F. inside.~~
2. Plenum Panels: Construct outside air plenum and mixing box housing panels with solid sheetmetal on both sides of the insulation. Construct these panels to prevent condensation with operating conditions equal to the ASHRAE winter outdoor design conditions inside the housings and with 78° F. and 50% relative humidity outside.
- C. Pipe Sleeves: Provide sleeved and flanged openings through housing and plenum walls for piping penetrations.
- D. Access Doors: Provide housing doors sized as shown on the Drawings, . Construct doors from 2 inch, double walled panels, properly braced and stiffened and provided with hinges and latches as described below. Latches shall be compression-type latches with inside and outside handles. Provide neoprene gaskets all around each door. Provide construction similar to that shown in the SMACNA Duct Standards Manual for the pressure class of the system.
- | Door Height
(inches) | Number of Hinges | Number of Latches |
|-------------------------|------------------|-------------------|
| Less than 36 | 2 | 1 |
| 36 to 60 | 3 | 2 |
| 60 to 85 | 4 | 3 |
| 85 to 144 | 5 | 4 |
| Over 144 | 1 per 30" | 1 per 36" |
- E. Framing: Use at least 16 gage steel angle frames to construct a rigid, stable housing with all roof and wall panels firmly connected.

2.4 LIGHTING

- ~~A-F. Lights and switches will be provided in each section of the housing by Division 16.~~

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Bolt all sections together to form a rigid, air tight assembly. Assemble the units according to SMACNA standards and install all components in accordance with the manufacturer's written recommendations.

END OF SECTION

SECTION 23 34 16

FANS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide fans and accessories in the configurations and locations shown on the Drawings. Refer to the schedule on the Drawings for model numbers and capacities. Provide the following types of fans:
 - 1. Centrifugal fans
 - 2. Axial fans

1.2 QUALITY ASSURANCE

- A. Provide fans with performance and acoustics certified by an Air Moving and Conditioning Association (AMCA) ratings seal.
- B. Provide products from manufacturers with local representatives who offer parts and service for the fans used on this Project.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. General: Submit Shop Drawings with product data for each manufactured item.
 - 2. Instructions: Submit equipment brochures, manufacturer's written installation instructions and electrical power requirements.
 - 3. Description: Submit a physical description of each fan including drawings and dimensions. Include the model number, operating weight and the manufacturer's fan curve.
 - 4. Certification: Submit documented verification that fan selections are AMCA-rated for air and sound performance.
- B. Test Results: After start-up, testing and balancing, provide the Owner with a vibration signature for each vane axial fan. With this vibration signature, include a document certifying that the fan is operating properly and the name and address of a local, factory qualified parts and service organization.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Centrifugal Fans:
 - 1. Cabinet Fans:
 - a. Small Cabinet Fans: Cook, Greenheck, Acme, Carnes, Jenn-Air, Penn.
 - b. Large Cabinet Fans: McQuay, Bohn, Carrier, Trane, York, Dunham-Bush.
 - c. Ceiling Fans: Cook, Greenheck, Acme, Carnes, Jenn-Air, Penn.
 - 2. In-Line Centrifugal Fans:

- a. In-Line Centrifugal Fans: Cook, Greenheck, Acme, Carnes, Jenn-Air, Penn, Trane.
 - b. Heavy Duty In-Line Centrifugal Fans: Barry Blower, Chicago Blower, Peerless, Twin City Blower.
 - 3. Power Roof Ventilators (PRV's):
 - a. General Service PRV's: Cook, Greenheck, Acme, Carnes, Jenn-Air, Penn, American.
 - b. Up-Blast PRV's for Kitchen Exhaust: Cook, Greenheck, Acme, Carnes, Jenn-Air, Penn, Ammerman.
 - c. Kitchen PRV's for Heavy-Duty Grease Removal: Penn, Bayley, Cook.
 - 4. Utility Blowers:
 - a. General Purpose [and Kitchen Hood] Utility Sets: Barry Blower, Greenheck, Carnes, Cook, Acme, Champion, Peerless, Twin City Blower, Trane.
 - b. Laboratory Utility Blowers: Barry Blower, Chicago Blower, Peerless, Twin City Blower.
 - B. Axial Fans:
 - 1. Belt-drive vane axial: Barry Blower, Chicago Blower.
 - 2. Direct-drive vane axial: Joy, Chicago Blower.
 - 3. Tube axial fans: Barry Blower, Chicago Blower, Trane, Woods.
- 2.2 GENERAL

- A. Motors: Provide motors with the electrical characteristics listed in the schedules on the Drawings. Furnish single-phase motors with built-in thermal overload protection. Provide motors, drives and power factor correction as specified in Section 23 05 13.
- B. Drives: Extend lubrication lines to fittings accessible while the fan is running. For belt-drive fans, mount motors on adjustable bases, separate the motor and drive from the air stream and connect the motor to the fan through an adjustable motor sheave. For each belt-drive, provide an OSHA-approved belt guard that has openings for tachometer readings at both pulleys. Refer to Section 23 05 13, Motors and Drives.
- C. Vibration: Select fan assemblies that will operate without passing through their first critical speed.

2.3 SMALL CABINET FANS

- ~~A. Equal to Greenheck Type CSP as scheduled on the Drawings.~~
- ~~B.A.~~ General: Provide each fan with a steel housing, acoustically lined and finished in baked enamel. Include a gravity backdraft damper and motor mounts with resilient isolators.
- ~~C.B.~~ Speed Control: Provide a solid state speed controller to allow manual adjustment of the fan speed from 100% capacity to about 50% capacity.

2.4 LARGE CABINET FANS

- ~~A. Equal to McQuay Type LYF as scheduled on the Drawings.~~
- ~~B.A.~~ Cabinets: Provide internally insulated cabinets of frame-and-panel construction with panels fabricated from galvanized or bonderized steel finished with baked enamel. Provide access for servicing fans and motor drives inside cabinets without removing cabinets from their mounts.

~~C.B.~~ Fans: Provide fans with forward curved, backward inclined or airfoil wheels, as scheduled on the Drawings. Provide double width, dual inlet (DWDI) fans with galvanized steel scrolls and housings. Dynamically balance the fan wheels before and after they are installed in the fan cabinet.

~~D.C.~~ Drives: Provide a belt-drive system for each fan. Support fan shafts on self-aligning, grease lubricated ball bearings rated for 200,000 hours of operation.

~~E.D.~~ Speed Control: Provide a solid state speed controller for manual adjustment of the fan speed from about 50% capacity to 100% capacity.

2.5 CEILING FANS

~~A.~~ ~~Equal to Greenheck Type SP as scheduled on the Drawings.~~

~~B.A.~~ General: Provide each fan with an acoustically lined, steel housing, a gravity backdraft damper and a finished ceiling grille.

~~C.B.~~ Discharge: Furnish fans with adjustable discharge configurations for either horizontal or vertical airflow.

~~D.C.~~ Speed Control: Provide a solid state speed controller to allow manual adjustment of the fan speed from 100% capacity to about 50% capacity.

2.6 IN-LINE CENTRIFUGAL FANS

~~A.~~ ~~Equal to Greenheck Type BSQ/BSQ-HP as scheduled on the Drawings.~~

~~B.A.~~ Fans: Provide fans with aluminum airfoil or backward inclined wheels as scheduled on the Drawings. Statically and dynamically balance each fan at the factory. The manufacturer shall rebalance them in the field, if necessary to keep vibration within the Owner's acceptable limits.

~~C.B.~~ Drives: Provide either direct-drive or belt-drive fans as indicated by the model numbers in the schedule on the Drawings. Support fan shafts on self-aligning, grease lubricated ball bearings rated for an average life of 200,000 hours.

~~D.C.~~ Housings: Provide each fan with an acoustically lined housing. Provide access doors located for servicing. Provide an inlet screen for any fan not connected to a duct.

~~E.D.~~ Electrical: Provide an external junction box and disconnect switch mounted on each unit.

~~F.E.~~ Speed Control: Provide a solid state speed controller to allow manual adjustment of the fan speed from 100% capacity to about 50% capacity.

2.7 HEAVY DUTY IN-LINE CENTRIFUGAL FANS

~~A.~~ ~~Equal to Barry Blower Tubular 8000 as scheduled on the Drawings.~~

~~B.A.~~ Fans: Provide aluminum airfoil wheels statically and dynamically balanced at the factory. Fabricate aluminum wheels so the blades are continuously welded to the backplate and the wheel cone.

~~C.B.~~ Housings: Provide each fan with an acoustically lined, continuously welded steel housing. Provide an inlet screen on any fan not connected to a duct. Provide a [bolted] [quick opening, hinged] access door directly over the wheel on each housing. Provide integral

straightening vanes, bolted inlet cones, bolted access panels on the discharge end and one of the following mounting systems depending upon the configuration of the unit:

Unit Configuration

Horizontal, floor mount
Horizontal, ceiling hung
Vertical floor mount
Vertical ceiling hung

Mounting System

mounting base
suspension brackets
reinforced end brackets
reinforced end brackets

~~D.C.~~ Drives: Provide only belt-drive blowers with non-overloading motors. Mount the fan shaft on heavy duty ball bearings rated for an L-10 life of 40,000 hours minimum or an average fatigue life of at least 200,000 hours.

~~E.D.~~ Electrical: Provide an external junction box and disconnect switch mounted on each unit.

2.8 POWER ROOF VENTILATORS (PRVs)

~~A.~~ ~~Equal to Greenheck Type G or GB as scheduled on the Drawings.~~

~~B.A.~~ Fans: Provide aluminum, backward inclined wheels statically and dynamically balanced at the factory. The manufacturer shall rebalance them in the field, if necessary to keep vibration within the Owner's acceptable limits.

~~C.B.~~ Motors: Provide at least 1/4 HP fan motors with permanently lubricated, sealed ball bearings. Select motors to be non-overloading.

~~D.C.~~ Drives: Provide either direct-drive or belt-drive PRV's as indicated by the model numbers in the schedule on the Drawings. ~~Provide lubricants and drives suitable for operation at temperatures as low as 30° F.~~

~~E.D.~~ Speed Control: On direct-drive units provide a unit-mounted, solid state speed controller to allow manual adjustment of the fan speed from 100% capacity to about 50% capacity.

~~F.E.~~ Shrouds: Enclose fan wheels inside aluminum shrouds made with a rolled bead and wind band. Provide a bird screen with each PRV. In lieu of the OSHA-approved belt guard specified generally for all belt-drive fans, enclose the motor and drive in a weather-tight compartment. Provide such compartment separated from the fan air stream and fitted with an outside air passage for motor cooling.

~~G.F.~~ Electrical: Provide an electric disconnect switch with each PRV.

~~H.G.~~ Damper: Provide an electric, motorized damper on each PRV. Set up the damper to open before the fan starts and close when it stops. Provide an extended, aluminum base for access to the damper. Use dampers that comply with the requirements of Section 23 09 00, Building Control Systems.

~~I.H.~~ Electrical: Provide an electric damper operator of the same voltage as the fan motor. Otherwise, provide a transformer for the damper motor.

~~J.I.~~ Roof Curbs: Provide an insulated, prefabricated roof curb with each PRV.

2.9 UTILITY BLOWERS

~~A.~~ ~~Equal to Cook Type SCA as scheduled on the Drawings.~~

- ~~B.A.~~ Fans: Provide steel, backward inclined wheels statically and dynamically balanced at the factory. The manufacturer shall rebalance them in the field, if necessary to keep vibration within the Owner's acceptable limits.
- ~~C.B.~~ Drives: Provide only belt-drive fans with non-overloading motors. Mount fan shafts on grease-lubricated roller or ball bearings rated for an average life of 200,000 hours.
- ~~D.C.~~ Weather Housings: Provide outdoor units with weather tight enclosures for the fan, motor and drive assembly. Construct weather enclosures of hot dipped galvanized steel and paint them with a weather-resistant enamel. Vent weather enclosures to cool the motors, and include access doors and removable panels for maintenance. ~~Provide a drain pipe system for the blower housing, and provide lubricants and drives that are suitable for operation at temperatures as low as -30° F.~~

2.10 LABORATORY UTILITY BLOWERS

- A. ~~Equal to Barry Blower Versacon "R" as scheduled on the Drawings.~~ Provide all laboratory utility blowers with spark resistant construction.
- B. Fans: Provide aluminum, backward inclined wheels statically and dynamically balanced at the factory. Fabricate the wheels so the blades are continuously welded to the backplate and the wheel cone. Select fans so the first critical speed is at least 125% of the fan's maximum operating speed. The manufacturer shall rebalance them in the field, if necessary to keep vibration within the Owner's acceptable limits.
- C. Housings: Enclose fan wheels in continuously welded steel housings. Brace the housings to resist vibration and pulsations. Provide each fan with bolted inlet and discharge flanges, a plugged scroll drain, airtight shaft seals, and gaskets or caulking to seal any other bolted joints.
- D. Coatings: Coat all interior {and exterior surfaces} of each fan with six coats of baked phenolic, approximately 6 mils thick when dry. Use Plastite, Heresite or an approved equal coating.
- E. Drives: Provide only belt-drive fans with non-overloading motors. Mount each fan on a 1040-45 SAE steel shaft.
- F. Bearings: Mount each fan shaft on self-aligning bearings with an L-10 life of at least 80,000 hours, or an average fatigue life of at least 200,000 hours. Use either single-row ball bearings mounted in one-piece, cast iron pillowblock or double-row spherical roller bearings mounted in a split, cast iron pillowblock.
- G. Weather Housings: Provide outdoor units with weather tight enclosures for the fan, motor and drive assembly. Construct weather enclosures of hot dipped galvanized steel and paint them with a weather-resistant enamel. Vent weather enclosures to cool the motors, and include access doors and removable panels for maintenance. ~~Provide a drain pipe system for the blower housing, and provide lubricants and drives that are suitable for operation at temperatures as low as -30° F.~~

PART 3 - EXECUTION

3.1 INSTALLATION – MECHANICAL CONTRACTOR'S RESPONSIBILITIES

- A. Install fans as shown on the Drawings and in compliance with the written recommendations of the manufacturer.

- B. Vibration: Refer to Section 23 05 48, for specific isolation requirements, but isolate fans according to the written recommendations of the fan manufacturer. Generally, use vibration isolators to isolate in-line centrifugal fans, vane axial fans and utility blowers from the building structure. In addition, restrain each vane axial fan with horizontal thrust restraints. Provide flexible duct connections between isolated fans and their connections to ducts or plenums supported from the building structure. {For laboratory utility fans, provide two layers of flexible duct connections at the fan inlet and a rigid, flanged connection at the fan discharge.} _Also provide flexible duct connections at the locations shown on the Drawings.
- C. Roof Penetrations: Provide a watertight plenum beneath each roof-mounted exhaust fan or PRV. Construct the plenum as shown in the details on the Drawings.

3.2 TEST AND START-UP - FAN SUPPLIERS' RESPONSIBILITIES

- A. Field Balancing (All Fans): For fans that are specified to be statically and dynamically balanced at the factory, rebalance any such fan after installation it produces noise that is objectionable to the Owner.
- B. Axial Fans: Provide a factory-trained service representative to check axial fans after installation and to do an initial test and start-up of each fan system. After start-up, testing and balancing, verify that the systems are operating properly and then provide the Owner with a vibration signature of each fan. These vibration signatures will form the basis for the Owner's preventative maintenance program for these fan systems.

END OF SECTION

SECTION 23 36 00

AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Fan-coil units

1.2 QUALITY ASSURANCE

- A. Equipment to be product of a manufacturer regularly engaged in the production of specified equipment who issues catalog data on such products.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Fan-coil units: McQuay, Airtherm, American Air Filter, Dunham-Bush, Trane, International.

2.2 PERFORMANCE

- A. Unless noted otherwise fan-coil unit capacities on 55° F. entering air temperature, 180° F. average water temperature.

2.3 FAN-COIL UNITS

- A. Equal to McQuay Thinline fan-coil units as scheduled on drawings.
- B. General: Fan-coil units shall be for two-pipe system with types, sizes and performance as scheduled on the drawings.
- C. Casings and Cabinets:
 - 1. ~~Equal to McQuay Type TSH:~~ Hideaway unit designed for fully concealed installations. Ceiling enclosure by others.
 - 2. ~~Equal to McQuay Type TSC:~~ Ceiling units designed for ceiling mounting. Includes a decorative cabinet with a stamped air discharge grille. Cabinet finished in heat fused epoxy over galvanized steel. Hinged bottom panel provides total accessibility to the unit, controls, and filter. The three-speed fan speed controller is furnished separately for wall mounting. Attractive stamped return air grille in the hinged bottom panel.
 - 3. ~~Equal to McQuay Type TCH:~~ Unit with hinged ceiling panel designed for recessed ceiling applications. Totally enclosed in a cabinet with ceiling frame and decorator style hinged access panel. Ceiling frame and access panel are adjustable to permit easy field adaptation to any ceiling type for custom fit and maximum accessibility to the unit and controls. Cabinet design permits complete removal of the basic unit for installation in steps coinciding with the various trades. Available with a back duct collar in lieu of a bottom stamped return air grille.
 - 4. ~~Equal to McQuay Type TSF:~~ Designed for use in three different types of installations: as a floor console most frequently located below a window for draft-free performance in the conditioned area; as a wall hung console in areas where a cove or molding

prevents the use of a floor console; or as a semi-recessed console for areas where a minimum of cabinet projection is desirable.

5. Equal to McQuay Type TSB: Designed for applications that require a fully concealed or a fully recessed installation. Furnished with base casing with fan speed controller furnished separately for wall mounting. Decorative wall plates with stamped return air grilles for use with recessed units with without air discharge grille and with access doors. Wall plates are galvanized steel with rounded corners and have heat fused epoxy finish.
- D. Coils: HI-F rippled aluminum fins with 1/2 inch O.D. copper tubes mechanically expanded for a permanent bond. Water coils shall have a manual air vent. Coil performance as tabulated in the schedule.
- E. Fans: DWDI forwardly curved, centrifugal type. Fan housing shall be fabricated of heavy galvanized steel and of 2-piece construction with removable front half for complete access to fans.
- F. Motors: 120v/1Ph/60Hz single speed, sleeve bearing, permanent split capacitor motors with oilers, inherent thermal overload protection with automatic reset and resilient mounts, and designed for use with a solid state variable speed controller.
- G. Speed Controller: Unit mounted solid state variable speed controller with integral "on-off" switch which shall provide uniform unlimited fan speed adjustment from high to low. It shall include a voltage compensating circuit and RFI filter circuit.
- H. Thermostat: Unit mounted and sequence 2-way valves at heating coil and cooling coil. Provide a switch to permit constant fan operation or cycling of the fan with the thermostat.
- I. Primary Drain Pan: Constructed of 20-gage galvanized steel, insulated on the under side with closed cell insulation. Secondary drain pan shall be mastic coated. Primary and secondary drain pans shall be equipped with 7/8 inch O.D. sweat connections.
- J. Cabinet Insulation: 1/2 inch fiber free liner.
- K. Filters: 1 inch thick throwaway type. TSH Unit: 1 inch throwaway filters with optional return air plenum.

2.4 HORIZONTAL FAN-COIL UNITS (BELT-DRIVEN)

- A. Equal to McQuay Type SCB as scheduled.
- B. General: Horizontal fan-coil units, belt driven, high capacity type.
- C. Casing: Fabricated of continuous 18-gage galvanized steel with duct collars and 1-inch thick, 2.0 lb/cu. Ft. internal foil face insulation.
- D. Coils: Standard cooling coil and separate heating coils, constructed of seamless copper tubes and headers with rippled aluminum fins. Tubes shall be expanded onto the fins. All coils to have manual air vents.
- E. Fan Housing: Galvanized steel, 2-piece, die formed with integral scroll and inlets. Fan wheel to be aluminum, DWDI, forwardly curved, and statically and dynamically balanced.
- F. Motor Mounts: Adjustable, with V-belt drive and adjustable motor pulley.

- G. Drain Pan: Non-corrosive and double sloped with copper drain connection.
- H. Filters: Nominal 2-inch thick throwaway type.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide each unit with shut-off valve on supply and balancing valve on return piping.
- B. Provide each unit with easily accessible manual air vent at high points. If not easily accessible, extend vent to exterior surface of cabinet for easy servicing.
- C. Anchor chilled water and hot water supply and return risers at an intermediate level slab, as shown on drawings. Provide swing joints at top and bottom of hot water risers to allow 1 inch expansion.

END OF SECTION

SECTION 23 37 13

AIR DISTRIBUTION DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Diffusers
- B. Grilles and registers
- ~~C. Laminar flow unitary panels~~
- ~~D.C. Variable~~Constant Air Volume (~~VAV~~CAV) terminal units
- ~~E. Variable Air Volume (VAV) extract terminal units~~
- ~~F. Laboratory Variable Air Volume (VAV) supply terminal units~~
- ~~G.D. Laboratory Variable Air Volume (VAV) extract terminal units~~

1.2 QUALITY ASSURANCE

- A. Make air flow tests and sound level measurements in accordance with applicable ANSI/ASHRAE equipment test codes and standards.
- B. Manufacturer shall certify cataloged performance and ensure correct application of air outlet types.

1.3 JOB CONDITIONS

- A. Review requirements of outlets as to size, finish, and type of mounting prior to submitting shop drawings and schedules of outlets.
- B. Check location of outlets and make necessary adjustments in position to conform with architectural features, symmetry and lighting arrangement.

1.4 SUBMITTALS

- A. Furnish shop drawings for all equipment provided under this Section. ~~Variable~~Constant air volume box submittals shall include point-to-point piping or wiring diagrams with all setpoints indicated. Where control sequences require relays or other devices for proper operation, include submittal data on those devices. Include calibration instructions with submittals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Grilles, Registers and Diffusers: Titus, Anemostat, Krueger, Metalaire, Price, or approved equal.
- B. Laminar Flow Unitary Panels: Titus, Anemostat, Krueger, Metalaire, Price, or approved equal.

- C. Constant Air Volume (~~VAV~~CAV) terminal units: Envirotec, Titus, Anemostat, Krueger, Metalaire, Price, or approved equal.

2.2 APPLICATION

- A. Rate units in accordance with ANSI/ASHRAE Standard 70-1991.
- B. Base air outlet application on space noise level of NC 35 maximum.
- C. Provide supply outlets with sponge rubber seal around edge.
- D. Provide baffles to direct air away from walls, columns, or other obstructions within radius of diffuser operation.
- E. Sizes as noted on drawings.

2.3 SCHEDULE OF GRILLES, REGISTERS AND DIFFUSERS

- A. Refer to schedule on drawings.
- B. Unless noted otherwise on the schedule, finish all ceiling mounted devices with a white, baked enamel finish. Paint all other exposed devices that are not mounted in the ceiling with a prime coat for finish painting in the field by others.
- C. Verify frame style required to accommodate ceiling and wall construction.
- D. Provide fire rated three hour rated ceiling diffusers as scheduled on drawings. Include thermal blanket. Install as described and illustrated in UL Fire Resistance Directory and per NFPA 90A.

2.4 ~~VARIABLE~~ CONSTANT AIR VOLUME (~~VAV~~CAV) SUPPLY TERMINAL UNITS

- A. General requirements of all supply terminal units:
 - 1. Terminals shall be certified under the ARI Standard 880 Certification Program and carry the ARI Seal. Noncertified terminals may be submitted after testing at an independent testing laboratory under conditions selected by the engineering consultant in full compliance with ARI Standard 880. These tests must be witnessed by the engineering consultant with all costs to be borne by the terminal manufacturer. Testing does not ensure acceptance.
 - 2. The terminal casing shall be minimum 22 gage galvanized steel. The units shall be lined with 1" thick dual density insulation, meeting UL 181 and NFPA 90A, enclosed between the unit casing and a non-perforated internal 22 gauge sheet metal cover extending over the fiberglass insulation, as well as covering the liner cut edges. The discharge connection shall be slip and drive construction for attachment to metal ductwork.
 - 3. The damper shall be heavy gauge steel with shaft rotating in ~~Delrin~~ self-lubricating bearings. Nylon bearings are not acceptable. Shaft shall be clearly marked on the end to indicate damper position. Stickers or other removable markings are not acceptable. The damper shall incorporate a mechanical stop to prevent overstroking and a synthetic seal to limit close-off leakage.
 - 4. Actuators shall be capable of supplying at least 35 in.-lb. of torque to the damper shaft and shall be mounted externally for service access. Terminals with internal actuator

mounting or linkage connection must include gasketed access panel, removable without disturbing ductwork.

5. ~~VAVCAV~~ box flow sensors shall be furnished and installed by the box manufacturer. Sensors shall take multiple readings across the box inlet and be of the averaging type. Sensors shall be of metal construction. Plastic construction is allowable where materials are rated for use in the airstream, and where the sensor is reinforced with metal framing.
6. Provide external taps from the flow sensors for hook-up to a magnehelic gauge in order to read the cfm through the box.
7. All controls, plastic tubing, wiring, and damper operators shall be enclosed by a metal cover or have fire resistant rating for use in return air plenum. All tubing and tubing connection fittings shall comply with materials requirements of Section 23 09 00, Building Control Systems. All wiring shall comply with Division 246 requirements.
8. Each box shall have attached information of flow charts for CFM measurement, box type and instructions for calibration.
9. All cfm settings are to be controlled by inlet velocity sensing. Mechanical stops are unacceptable.
10. Where ~~variable~~Constant air volume box control is electronic, include the primary air damper. Flow sensors will be provided as described above. The damper actuators and controllers will be furnished by the Temperature Controls Contractor and sent to the ~~VAVCAV~~ box manufacturer's factory for factory installing. Calibration of those controllers remains the responsibility of the Temperature Control Contractor.
11. ~~VAVCAV~~ box control shall be pressure independent.
12. Furnish hot water heating coils with capacities as indicated on the drawings. Control valves for hot water coils will be provided under Section 23 09 00, Building Control Systems.
13. Provide access panels on all ~~VAVCAV~~ boxes with built-in heating coil. Access panels shall be insulated and of similar construction as ~~VAVCAV~~ box casing, located upstream of the reheat coil, include quick release fasteners, and be gasketed to provide an air tight seal when installed.

B. Type 1 ~~Variable~~Constant Air Volume Box:

1. ~~Furnish and install TITUS Model DESV single duct, variable air volume terminals of the sizes and capacities shown in the plans.~~
2. Box minimum shall be factory set at 30% of the maximum desired cfm unless noted otherwise on the drawings. Discharge NC shall not exceed 30 at the maximum cfm based on 1/2 inch water gauge inlet static pressure, five feet of 1 inch lined duct, and 10 dB room attenuation. Radiated NC shall not exceed 30. Boxes shall have not greater than 0.10 inch water gauge pressure drop across the box at selected flow rates.
3. Refer to [drawings for control functions.

~~2.5~~ VARIABLE AIR VOLUME (VAV) EXTRACT TERMINAL UNITS

~~A. General requirements of all supply terminal units:~~

1. ~~Terminals shall be certified under the ARI Standard 880 Certification Program and carry the ARI Seal. Noncertified terminals may be submitted after testing at an~~

~~independent testing laboratory under conditions selected by the engineering consultant in full compliance with ARI Standard 880. These tests must be witnessed by the engineering consultant with all costs to be borne by the terminal manufacturer. Testing does not ensure acceptance.~~

- ~~2. The terminal casing shall be minimum 22 gage galvanized steel. The units shall be lined with 1" thick dual density insulation, meeting UL 181 and NFPA 90A, enclosed between the unit casing and a non-perforated internal 22 gauge sheet metal cover extending over the fiberglass insulation, as well as covering the liner cut edges. The discharge connection shall be slip and drive construction for attachment to metal ductwork.~~
- ~~3. The damper shall be heavy gauge steel with shaft rotating in Delrin® self-lubricating bearings. Nylon bearings are not acceptable. Shaft shall be clearly marked on the end to indicate damper position. Stickers or other removable markings are not acceptable. The damper shall incorporate a mechanical stop to prevent overstroking and a synthetic seal to limit close-off leakage.~~
- ~~4. Actuators shall be capable of supplying at least 35 in.-lb. of torque to the damper shaft and shall be mounted externally for service access. Terminals with internal actuator mounting or linkage connection must include gasketed access panel, removable without disturbing ductwork.~~
- ~~5. VAV box flow sensors shall be furnished and installed by the box manufacturer. Sensors shall be easily field convertible from high range to low range without having to remove ductwork or the VAV box. Sensors shall take multiple readings across the box inlet and be of the averaging type. Sensors shall be of metal construction. Plastic construction is allowable where materials are rated for use in the airstream, and where the sensor is reinforced with metal framing.~~
- ~~6. Provide external taps from the flow sensors for hook-up to a magnehelic gauge in order to read the cfm through the box.~~
- ~~7. All controls, plastic tubing, wiring, and damper operators shall be enclosed by a metal cover or have fire resistant rating for use in return air plenum. All tubing and tubing connection fittings shall comply with materials requirements of Section 23 09 00, Building Control Systems. All wiring shall comply with Division 16 requirements.~~
- ~~8. Each box shall have attached information of flow charts for CFM measurement, box type and instructions for calibration.~~
- ~~9. Boxes shall have external adjustments for field setting of maximum and minimum air volumes. All cfm settings are to be controlled by inlet velocity sensing. Mechanical stops are unacceptable.~~
- ~~10. Where variable air volume box control is electronic, include the primary air damper. Flow sensors will be provided as described above. The damper actuators and controllers will be furnished by the Temperature Controls Contractor and sent to the VAV box manufacturer's factory for factory installing. Calibration of those controllers remains the responsibility of the Temperature Control Contractor.~~
- ~~11. VAV box control shall be pressure independent.~~
- ~~12. VAV boxes shall be field changeable between normally open and normally closed operation, and direct acting and reverse acting operation, without the need for additional components.~~
- ~~13. Air volume controller shall control air volume within plus or minus 5% of design air volume regardless of changes in system static pressure.~~

~~B. Type 1 Extract Variable Air Volume Box:~~

- ~~1. Equal to Anemostat Model XFASDT. Used with air supply box to provide tracking between the space air supply and exhaust/return.~~
- ~~2. Integral ASTC Submaster Tracking Control and DVT duct velocity transmitter that enables the extract box to track the master supply box.~~
- ~~3. Boxes shall include factory installed radiated noise shroud.~~
- ~~4. Box shall be factory set at desired minimum and maximum air volume. Discharge NC shall not exceed 30 at the maximum cfm based on 1/2 inch water gauge inlet static pressure, five feet of 1 inch lined duct, and 10 dB room attenuation. Radiated NC shall not exceed 30. Boxes shall have not greater than 0.10 inch water gauge pressure drop across the box at selected flow rates.~~
- ~~5.4. Refer to Section 23-09-93, Control Sequences of Operation, for control functions.~~

PART 3 - EXECUTION

3.1 INSTALLATION

A. Grilles, Register and Diffusers:

1. Install items in accordance with manufacturers' printed instructions. Rigidly fasten ducts behind grilles, registers and diffusers.
2. Supplier and contractor shall work very closely with ceiling contractor and electrical contractor to coordinate the installation of the Multi-Vent type ceiling panels.
3. Provide the required air throw and spread with no apparent drafts or excessive air movement within the conditioned area. Provide air distribution accessories necessary to effect these conditions. Replace devices causing excessive noise, drafts and air movements. Adjust cores to direct air pattern to avoid downdrafts and excessive air movement. Adjust directional tabs in square diffusers and in linear diffusers to provide proper air distribution pattern.
4. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
5. Install diffusers to ductwork with airtight connection.
6. Provide balancing dampers on duct take-off to diffusers, grilles and registers, regardless of whether dampers are specified as part of the diffuser, grille and register assembly.
7. Paint ductwork visible behind air outlets and inlets matte black. (2 coats). Extend painting inside duct as far as is visible through the outlet and inlet.
8. Provide diffusers, registers and grilles with sheet metal round to square transitions as required by duct attachment. Duct size as shown on drawings.
9. Sizes shown on drawings for diffusers, registers and grilles are "neck" sizes. Size of face shall depend on ceiling/wall/floor application. Where diffusers/registers/grilles are provided for lay-in suspended type ceilings, the nominal size of face shall be 24 by 24 inch or 24 by 48 inch unless otherwise shown.
10. Where sufficient clearance is unavailable to provide a smooth radius branch duct connection to neck, provide a sheet metal plenum at diffuser/register neck and connect duct at side of plenum.

11. Paint integral opposed blade dampers matte black (2 coats).
 12. Provide extractor for outlets/inlets located at exposed duct.
 13. Provide support of inlets/outlets independent of ceiling.
- B. Support of ~~Steriflo~~ Operating Room Particulate Control Systems (similar to Krueger "Steriflo") as follows:
1. Support ~~the Steriflo~~ air distribution system to the structure above. The ceiling cannot support the system.
 2. ~~Steriflo perimeter, including plenum, face and distribution devices weigh 15 pounds per lineal foot of length. The perimeter elbows weigh 25 pounds each. Drill the continuous hanger angles every 4 feet on center on both sides and extend 1/2 1/2" diameter hanger rods up to the structure in accordance with manufacturer's recommendations. Seismically brace the system to resist lateral movement in all directions.~~
 3. Support and brace as detailed on Drawings.
 4. ~~The Steriflo center panels weigh 20 pounds per square foot.~~
 5. Support the center grid system similar to the suspended ceiling grid system. Support as shown on the architectural drawings.
- C. Support the ~~Krueger~~ Operating Room Diffuser (ORD) panels as follows:
1. Support the grid system and the panels to the structure above.
 2. Provide 4 hanger wires for each ORD panel and connect to the four corner hanger brackets on the backpans.
 3. Support the center grid system similar to the suspended ceiling grid system. Support as shown on the architectural drawings.
- D. ~~Variable~~ Constant Air Volume Boxes:
1. Install in accordance with manufacturer's instructions.
 2. Coordinate installation of ~~VAV~~ CAV boxes, especially fan powered type, with all other trades so as to provide required access clearances for servicing those pieces of equipment.
 3. Refer to drawings for temperature control sequences.
 4. Provide minimum of three diameters of straight rigid duct on inlet of each ~~VAV~~ CAV box.
 5. Provide ceiling access doors or locate units above easily removable ceiling components.
 6. Support units individually from structure. Do not support from adjacent ductwork.
 7. Connect to ductwork in accordance with Section 23 31 10.
 8. Installation of all laboratory extract air valves and supply boxes shall be closely coordinated with the laboratory airflow control system supplier.

END OF SECTION

SECTION 23 73 23

FACTORY CUSTOM AIR HANDLING UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide factory custom, indoor central station air handling units as described in this Section and scheduled on the Drawings.

1.2 REFERENCE STANDARDS

- A. ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers)
- B. AMCA (Air Moving and Conditioning Association)
- C. ASTM (American Standards for Testing and Materials)
- D. NFPA (National Fire Protection Association)
- E. SMACNA (Sheet Metal and Air conditioning Contractors National Association)
- F. UL (Underwriter's Laboratories)

1.3 QUALITY ASSURANCE

- A. Fans shall bear the AMCA Certified Ratings Seal for air and sound performance in accordance with AMCA Standard 210 and ASHRAE Standard 51.
- B. Provide factory assembled air handling units that are the products of a manufacturer regularly engaged in manufacturing units of the size and type specified.
- C. All products furnished under this Specification shall be UL or ETL listed and shall conform to the requirements of all applicable codes.
- D. Coils shall bear the ARI certified ratings seal for performance.

E. Seismic Performance: Air handling unit shall withstand the effects of earthquake motion determined according to 2010 CBC. The term "withstand" means that the unit will remain in place without separation of any parts from the device when subjected to seismic forces specified. The unit shall remain fully operational after the seismic event. Each unit shall have a prominently displayed 2007 CBC Section 1708 A.5 Seismic Compliance Label issued by an independent third party approval agency which is specific for the size of the component and tested acceleration levels.

F. CBC Seismic Compliance:

1. All components included herein shall be designed, manufactured and independently tested, rates and certified to meet the seismic compliance standards of the California Building Code, 1708A.5 and OSHPD CAN 2-1708 latest edition. The units shall be designed, tested and certified to meet SDS load and wind load determined by a Structural Engineer.

2. All completed component assemblies shall be clearly labeled for field inspection. Labels shall include the manufacturer's identification, model number, serial number and definitive information describing the product's performance characteristics and the approved agency's identification.

3. In addition to all seismic requirements for CBC Certification listed elsewhere in the project specification, manufacturer's submittals shall include:

a. Manufacturer's Certificate of Compliance clearly indicating the equipment model being submitted, their Independent Certifying Agency, the Independent Certifying Agency's report number and the equipment's seismic conformance level.

a.b. Clear installation instructions including all accessory components that are part of the overall component installation necessary to support the definition of "on line".

1.4 SUBMITTALS

A. Furnish detailed shop drawings including performance capacities and dimensioned drawings for all equipment provided under this Section.

B. If an alternate manufacturer other than manufacturer scheduled on drawings is used, the dimensions of the unit must match those dimensions of the units shown on the drawings.

C. Manufacturer shall provide a seismic certification of compliance for equipment in conformance with California Building Code Section 1708A.5 including compliance with latest version of OSHPD CAN 2-1708 and latest addendum. This shall be for review and acceptance by the registered design professional in responsible charge of the seismic system and the building official. The manufacturer of designated equipment shall test or analyze the equipment and its mounting system or anchorage and submit a certificate of compliance for acceptance. Qualification shall be by an actual test on a shake table, by three-dimensional shock tests, by an analytical method using dynamic characteristics and forces, by the use of experience data, or by a more rigorous analysis providing for equivalent safety.

1.6 FACTORY TESTING

A. Witness of Factory Tests: The manufacturer shall include as part of bill of material a provision for two trips for two people including airfare, board and lodging to witness the following tests at the factory prior to shipment. Two units shall be selected by the mechanical engineer two weeks prior to shipment.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Air handler manufacturer:

1. Huntair
2. York

3. Temtrol
4. Energy Labs

2.2 GENERAL

- A. Provide draw-through air handling units as indicated on the Drawings. Basis of Design – Huntair/Concepts and Designs Inc. (CDI)
- B. Components: The schedule on the Drawings contains a specific list of the components required for each system. In general, provide the following air handling components for this Project:
 1. Centrifugal fan array sections
 2. Cooling, heating coil sections
 3. Humidifier sections
 4. Spacer/access sections
 5. Pre, post and final filter sections
 6. Mixing box sections
 7. Variable frequency controllers (VFDs)
 8. Air Flow Measuring Stations
 9. Discharge dampers
 10. Temperature Controls
 11. Ultra Violet Germicidal Irradiation System
- C. Air handling units shall be shipped in individual or combined sections as required by the project. Supply and return fan sections, mixing box section, pre and final filter sections shall be designed to be fitted up directly to each other and the dehumidification section which may be manufactured by another equipment manufacturer.
- D. Prior to be considered as equal, the Alternate Manufacturers above shall demonstrate full compliance with the specification requirements for the entire specification prior to the date of tender, scheduled unit performance, sound power, assembled unit vibration dynamics, energy consumption, operating and maintenance characteristics, weight and dimensions as compared to the Huntair air handling unit with Fanwall® system that is the basis of design. Alternate manufacturers are required to submit qualifications and detailed comparative performance data including, but not limited to, a listing of at least four projects where similar equipment sizes and configurations in similar critical applications of similar scope to that as specified herein have been in successful operation for at least four years prior to the tender date for the equipment for this project. Air Handling Units offered for tender shall have been manufactured with similar configurations, components, and for like application, and that must have been in beneficial use for at least four years prior to the tender date for this project. Listed alternate manufacturers must provide a list of four such installations along with facility contact information to the consulting engineer at least two weeks prior to the date of tender. Manufacturers not listed by name in these specifications will not be approved.

2.3 UNIT HOUSINGS

- A. PRESSURE RATING:

1. The unit housing shall be constructed to withstand a minimum internal positive pressure of 12 inches of water gauge. Leakage rate shall be 1% @ 10" W.G. and shall be certified in writing by an Officer of the Company.

B. CASING CONSTRUCTION:

1. Walls and roof to be 2" "Double Wall" construction as indicated in the specification for each section of the unit. Cabinet shall be with a minimum 16-gauge, G90 galvanized steel solid outer panel and a minimum 20-gauge G90 galvanized, inner liner. Panels to be of standing seam construction with seams turned inward to provide a smooth flush exterior. Panels to be screwed together on maximum 8" centers with minimum 5/16" zinc plated screws sealed with a continuous bead of silicone caulking applied between the matching panel seams prior to assembly (sandwiched and sealed by the compression of the panels), and with a final bead following assembly on both the exterior and interior panel seams to produce an air tight unit. Wall to base skin and wall to roof panel seams shall be sealed with 1/2" x 1/8" Poron-Rubber strips and all exterior seams shall be continuously caulked to assure leak-proof integrity of the unit housing. AHU unit housing shall be constructed to prevent conditioned air bypass or mitigation through unit walls, roof and floor around any interior partition or component blank-off walls such as for filters, coils or fan bulkheads. At the discretion of the design engineer, the manufacturer may be required to perform casing leak testing for purposes of demonstrating that the unit casing leakage rate at 1.5 times the design maximum fan operating static pressure is less than .5% of design airflow. Such testing will be performed at the manufacturer's facility. At the sole discretion of the design engineer, such testing shall be witnessed by an owner's representative. A certified test report of such testing shall be included in the O&M Manuals provided at the time of shipment of the equipment.

C. INSULATION:

1. Panels to be insulated with 2" - 3-pound double density, pre-molded, rigid board, fire-resistant, with matte face. Insulation to meet NFPA 90A, NFPA 90B and ASTM E 84 requirements for Flame Spread of 25 or less and Smoke Development of 50 or less. Insulation shall have a thermal conductivity K factor of .23 Btu/hr/Sq. ft/degree F @ 75 F mean and provide the following sound attenuation characteristics (per ASTM C 423 - Type "A" Mounting):

Octave bands	125	250	500	1k	2k	4k	8k
Absorption Coefficient	7	.80	1.16	1.15	1.11	1.10	1.05 (for 2"-3#)

All cut edges of the board insulation shall be completely enclosed by the unit panels. A finish bead of caulking will be applied over all foil to panel seams and/or inner liners to main panel seams to completely encapsulate the insulation.

2. Interior liners: to be minimum 20-gauge, G90, solid galvanized steel throughout the unit for the walls and roof. A finish bead of caulking will be applied between the liner and the interior panel seams to completely seal the panel.

D. ROOF PANELS:

1. On indoor units shall be flat with smooth exteriors the same as the side panels. Weatherproof roofs shall be constructed with raised seams. Raised Roof Seams to be sealed between sandwiched panels with a bead of silicone caulking. The top of each roof panel seam is to receive a final bead of caulking and be sealed with a 16-gauge roof cleat mechanically formed to enclose the standing seam at the roof panel to

panel joint. Roof to slope from center axis of roof to sides a minimum 1/8" per foot to allow complete water drainage and preclude standing water. Roof panels to overlap the side panels a minimum 1" all around the unit creating an overhang to reduce direct runoff from the roof down over the side panels. All doors and louvers shall have a formed rain shield extending a minimum of 1" from the wall to direct water away from the door and louver openings.

- E. Stiffeners of angle steel shall be supplied as required to maintain a casing deflection criteria of 1/100 at 1.5 times the working pressure.

2.4 ACCESS DOORS:

- A. Access doors shall be 2" double wall construction with G90 galvanized exterior panels and G90 galvanized interior panel. Door jam & frame shall be constructed of extruded aluminum with continuously welded corners for rigidity. Door panels shall be insulated with 2" expandable foam insulation completely encapsulated and sealed between the door panels and frame. Provide doors located and sized to allow for routine maintenance including motor replacement and filter replacement, electrical components and any other sections or components requiring access or maintenance.
- B. Doors shall be provided with a minimum of (2) dual acting heavy duty key locking composite latches through 48" high, (3) latches through 72" high. Latches shall be operable from both the interior and exterior of the unit. Door latches on doors into fan sections shall be provided with a hasp or other mechanism to facilitate locking of the doors. Door hinge shall be heavy duty Stainless Steel. Door shall be sealed with continuous hollow closed cell foam gasket.
- C. Doors to be provided with double high performance closed cell replaceable neoprene bulb type gasket seals around the entire perimeter of the door / frame.
- D. Doors shall open against static pressure unless obstructed by internal components. If obstructed by internal components on the positive sections requiring access, the doors shall open with pressure and shall be provided with a safety restraining mechanism. Doors used to access rotating equipment shall be provided with an OSHA approved safety latching mechanism requiring a tool to open and shall also have a highly visible, permanently fixed, caution sign on the exterior of the door. Doors with access to moving parts must also have locking hardware and meet current UL mechanical protection guidelines.
- E. Doors shall be provided with thermal pane wire glass viewing windows as called out for on the unit drawings in the specifications. Minimum window size to be 8" x 8" with 12" x 12" provided door size permitting.

2.5 ~~Bases~~ BASES:

- A. Unit bases shall be constructed from structural steel channel iron around the entire perimeter of the unit and provided with intermediate structural tubing, channel and angle iron as required to support all internal components. All tubing, channel and angle joints shall be solid welded. Bolted or formed channel bases are not acceptable.
- B. The unit base shall be covered with a 12-gauge floor with caulked seams. Base shall be provided with removable lifting lugs minimum (4) per section, properly located to assure uniform loading. Maximum spacing between lifting lugs shall be 120".

- C. Base shall be insulated with 1.25" polyurethane foam insulation under the base skin and covered with a minimum 20 gauge G90 galvanized steel liner. Insulation to meet same criteria as explained under the cabinet casing requirements.
- D. Drain pans shall be 304 Stainless Steel double-walled construction with solid welded seams for complete water capture and containment. Pans under cooling coils shall extend a minimum 12" past the leaving face of the coil in direction of airflow. Drain Pans shall be fully recessed in the unit floor and all headers and return bends shall be located over the drain pan for collection of all condensate forming on headers and return bends. All coils shall be easily removable without cutting or removing any portion of the drain pan. Pans shall be insulated between the liner and the main pan. Pans shall be IAQ Double Sloping to a single drain. Drain connection shall be a minimum 1-1/4" diameter MIPS thread extending out through the channel base the same side as the coil connections unless other wise indicated on the drawings. Pans shall be provided for cooling coils, humidifiers, outside air intakes and under other components as required. Mastic coated drain pans are not acceptable as they are "non-Cleanable".
- E. All large openings (greater than one square foot) in the floor, including dampers openings, shall be covered with a removable powder coated heavy gauge steel grating bolted in place suitable for walking on which will prevent any personnel and large objects from falling through into the space below. Grating shall be capable of supporting minimum 300 pounds.
- F. Provide a perimeter collar around the entire unit and around each floor opening to insure unit is watertight. The entire base shall act as a secondary drain pan to hold up to 1" of water.

2.6 COATINGS:

- A. All wall, roof, interior divider walls, racks, blank-offs and the Base Structure shall be coated with a Dry Powder - Baked Polyester coating similar to Tiger #7035, Drylac Series 49 or equal which is both lead and cadmium free. Each cabinet panel, panel liner and interior partition component is to be individually coated & baked following shearing, notching, punching, & forming to provide 100% powder coverage over the entire finished piece to include the interior, exterior and all metal edges. The coating process shall be completed prior to assembly of the unit to ensure that all joined surfaces (panel to panel joints), are covered. Spray or brush applied coatings on the exterior of the cabinet only are NOT acceptable. Powder Paint to have passed Salt Spray Resistance Test ASTM B 117-90 Minimum 7000 Hours, Impact Test ASTM D 2794-90 up to 160 lbs and Humidity Resistance Test ASTM D 2247-87 Minimum 7000-hour test w/ maximum blister 1/16 in/1 mm.
- B. Silver ion to be included in all interior surface coatings.
- C. Stainless steel is the only acceptable alternate for finish specified above.
- D. Color of unit to be white (or Architect / Owner specified).

2.7 SUPPLY AND RETURN FANS

- A. The fan system shall consist of multiple, direct driven, arrangement 4 plenum fans constructed per AMCA requirements for the duty specified, (Class I, II, or III). All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The fan array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Each fan/motor "cube" shall include an 11 gauge, G90 Galvanized steel intake wall, 14 gauge spun steel inlet funnel, and

an 11 gauge G90 Galvanized steel motor support plate and structure. The fan intake wall, inlet funnel, and motor support structure shall have same finish as specified in Section 7 above.

- B. Fans shall be selected so that if any one fan in the array fails, that the remaining fans can continue to supply the scheduled airflow at the scheduled static pressure. This capability must be demonstrated during the air balancing phase of construction.
- C. All motors shall be pedestal mounted type, Ultra-Efficient, TEFC, T-frame motors selected at the specified operating voltage and RPM as specified or scheduled elsewhere. Motors shall have performance and construction equal to or better than that scheduled below:
 - 1. 1.15 service factor, 40°C ambient
 - 2. Class F insulation, Class B temperature rise @ 1.0SF
 - 3. Insulation system shall meet or exceed NEMA MG1-2006, Part 31
 - 4. NEMA Design B, Continuous Duty
 - 5. Die Cast Construction
 - 6. Minimum Efficiency shall be per table below:

<i>HP</i>	<i>RPM</i>	<i>Voltage</i>	<i>FL Efficiency</i>
1	1800	208-230, 460	86.5
1	3600	208-230, 460	87.5
1.5	1800	208-230, 460	87.5
1.5	3600	208-230, 460	87.5
2	1800	208-230, 460	87.5
2	3600	208-230, 460	88.5
3	1800	208-230, 460	90.2
3	3600	208-230, 460	89.5
5	1800	208-230, 460	90.2
5	3600	208-230, 460	90.2
7.5	1800	208-230, 460	92.4
7.5	3600	208-230, 460	91.7
10	1800	208-230, 460	92.4
10	3600	208-230, 460	91.7
15	1800	208-230, 460	93.0
15	3600	208-230, 460	92.4
20	1800	208-230, 460	93.0
20	3600	208-230, 460	92.4

- D. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, category BV-5, to meet or exceed Grade 1.0 with a maximum of .55 mil peak (.022 in. per second peak, filter in) deflection at the design operating speed for the fan/motor assembly. Final balancing of the fan and motor combination shall be performed while the fan/motor is secured to the actual fan cell mounting rail. Certified copies of all dynamic balancing results for all fans shall be provided with the unit.
- E. Fan sections shall include overhead structural means for motor/blower removal assistance.

2.8 SOUND POWER LEVELS

A. The sound power level at the air handling unit discharge, air intake (return air and / or OSA intake), and casing radiated shall not exceed the values given in the table shown below, when the unit is operating at maximum design airflow and static Pressure.

B. Maximum Octave Band sound Power Level in dB RE 10E-12 watts

Unit Tag # (AC-18)

Octave Bands Center Freq.	63	125	250	500	1k	2k	4k	8k
Unit Inlet	80	84	85	83	79	79	77	71
Unit Outlet	79	87	88	81	80	78	73	66

Unit Tag # (AC-19)

Octave Bands Center Freq.	63	125	250	500	1k	2k	4k	8k
Unit Inlet	82	83	82	87	85	84	83	78
Unit Outlet	77	75	80	74	76	74	72	66

Unit Tag # (AC-20)

Octave Bands Center Freq.	63	125	250	500	1k	2k	4k	8k
Unit Inlet	74	74	67	71	71	69	65	57
Unit Outlet	77	72	75	75	77	75	73	68

Unit Tag # (AC-21)

Octave Bands Center Freq.	63	125	250	500	1k	2k	4k	8k
Unit Inlet	77	82	74	76	73	72	71	64
Unit Outlet	74	71	76	71	70	69	67	61

Unit Tag # (AC-22)

Octave Bands Center Freq.	63	125	250	500	1k	2k	4k	8k
Unit Inlet	83	80	78	78	75	75	72	64
Unit Outlet	83	78	81	81	83	80	79	74

Unit Tag # (AC-23)

Octave Bands Center Freq.	63	125	250	500	1k	2k	4k	8k
Unit Inlet	81	76	73	77	69	68	68	59
Unit Outlet	71	76	73	67	67	67	64	57

Unit Tag # (AC-24)

Octave Bands Center Freq.	63	125	250	500	1k	2k	4k	8k
Unit Inlet	87	85	83	85	78	76	76	68
Unit Outlet	73	69	78	76	70	70	68	62

Unit Tag # (AC-25)

Octave Bands Center Freq.	63	125	250	500	1k	2k	4k	8k
Unit Inlet	72	82	73	78	79	78	75	68
Unit Outlet	81	76	79	79	81	78	77	72

Unit Tag # (AC-26)

Octave Bands Center Freq.	63	125	250	500	1k	2k	4k	8k
Unit Inlet	72	82	73	78	79	78	75	68
Unit Outlet	82	77	80	80	82	79	78	73

- C. It shall be the option of the manufacturer to provide quieter fans, acoustical lining, sound traps or other sound attenuating devices within the air handling unit to supplement the design in order to meet the specified levels above. Such lining and/or attenuators shall have no exposed fiberglass or wool insulation. Lining material shall be USDA approved and shall meet the requirements of ASTM-E-800 and ASTM-E-682. Tedlar or other similar film over fiberglass or wool materials is not acceptable because of its susceptibility to damage.
- D. Manufacturers must submit acoustical data for review and approval prior to the bid indicating that the proposed equipment can meet all specified performance requirements without impacting the equipment performance or design features including duct connection locations, unit sizes and weights, acoustical performance, or specified total fan HP. Proposals submitted which indicate a higher connected fan HP than specified or scheduled will not be accepted. The submittal shall include a complete description of the methods and procedures used to develop the sound power levels being submitted.
- E. The Fanwall array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit not to exceed the specified cooling coil and/or filter bank face velocity when measured at a point 12" from the intake side of the Fanwall array intake plenum wall, and at a distance of 48" from the discharge side of the Fanwall intake plenum wall.

2.9 REDUNDANT VARIABLE FREQUENCY DRIVE CONTROL:

- A. Provide one Variable Frequency Drive for normal operation and a second Variable Frequency Drive for Redundant Backup operation. Provide control wiring and control circuitry to transfer from main VFD to Redundant VFD when main drive has faulted. The Variable Frequency Drives shall be sized to start and hold all motors in the Fanwall. Provide short circuit protection for each drive through means of using fuses with fuse blocks or circuit breakers.
- B. The Variable Frequency Drives shall be mounted in a dedicated enclosure for connection to single point power. Each individual Variable Frequency Drive shall be provided with it's own disconnecting means so that it can be electrically isolated while the other VFD is operational. Provide appropriate cooling of enclosure with clean, filtered air.
- C. Motor circuit protectors shall be used for each individual motor in the Fanwall array. Motor circuit protectors shall be housed and mounted in the VFD enclosure as required. Motor circuit protectors may be mounted in a remote enclosure that is separate from VFD enclosure if design requires. Variable frequency drive enclosure and remote Motor circuit protector enclosure must be mounted at a minimal distance from fan array motors and each other.
- D. Proof of motor "run" state shall be provided for each individual motor. Dry contacts shall be provided so that a fan "failure" state can be reported through the building automation system. An array of lights shall be provided to provide visual indication of which motor is in a "failed" state.
- E. Provide three phase power distribution wiring and control wiring as required. All three phase power components shall have a rating listed for Short Circuit Current Rating. Provide control wiring and components required for complete operation of fan wall system. System controls, controls components and control wiring shall include but is not limited to Auto mode or manual mode, CFM control mode, or BMS control mode. Controls and control wiring shall include auto start/stop, manual start stop, life safety shutdown, smoke shutdown, system

alarms and VFD alarms. All control wiring shall be included in VFD enclosure provided with system.

- F. VFD enclosure shall have the same finishes as those specified for the air handler.

2.10 2.11 SHAFT GROUNDING:

- A. Provide an AEGIS model "SGR" shaft grounding system for each AC motor to prevent electrical damage to motor bearings and to extend motor life by safely channeling harmful shaft currents to ground. The AGEGIS system is frictionless, has no wear and requires no maintenance or additional service during the life of the motor. No known equal.

2.11 COILS

- A. Chilled and Hot Water Coils shall be certified in accordance with ARI Standard 410 and must bear the ARI label. of the aluminum plate ripple fin .0075 aluminum, extended surface rated in for water, steam or ethylene/propylene glycol water mixture. The tubes shall have a minimum .025-wall thickness of seamless copper expanded into the fin collars to provide a permanent mechanical bond. No metallic or thermal bonding materials are acceptable. Return Bends shall be a minimum of one tube thickness greater than the main tubes (.035 brazed replaceable copper). "U" type shaped tubes are not acceptable. Coil headers shall be non-ferrous seamless copper, and provided with brass or copper male pipe connections. Pipe connections shall be same end connections. Each Coils supply & return connections shall be raised / lowered a minimum 6" from the bottom / top of the coil to allow room for piping connection hookup especially between stacked coils, coils near floors & coils near roofs. Each coil shall be provided with capped vent & drain connections extended to the exterior of the cabinet. All coils shall be fully drainable with no trapped tubes. Coils shall be counter flow design with connections either left or right hand as specified. The use of internal restrictive devices such as turbolater springs or ribbons to obtain turbulent construction is not acceptable.
- B. Coil casings shall be minimum 16 gauge 304 Stainless Steel, with formed 3/4" flanges on all sides of the coil with the tube sheets having pressed or extruded tube holes. The coil casing shall be reinforced so that the maximum unsupported length is 60". The reinforcements shall be of the same material as the casing. Both ends of the coil to be sealed off from the main air stream by full height blank off's on both the entering air and leaving air sides. Blank off's to be the same material as the coil casing. Headers and return bends to be further insulated with a closed cell neoprene gasket the full height & width of the coil casing to reduce condensation.
- C. All coils shall be tested and rated in accordance with the Air Conditioning and Refrigeration Institute (ARI) Standard 410 and certified in accordance with the ARI certification program. All tubes shall be tested at a minimum 1500 PSIG and all assemblies tested under water at 450 PSIG and rated for 250 PSIG working pressures. Individual tube and core tests before installation of header are not considered satisfactory. Hydrostatic tests alone will not be acceptable.
- D. Stacked coils: mounted with integral stacking flanges on the coil. Racks are to be designed to allow coil removal through the roof of the unit if required. All coils to be removable from either side of the unit by easily removable end panels. Individual end panels are to be supplied for each coil on the Supply & Return side of the cabinet to allow single coil piping breakdown for coil removal.

2.12 FILTERS

- A. Filters shall be arranged so that they are loaded from within the cabinet on the upstream side unless specifically indicated otherwise on the detail drawings. The filter rack assemblies shall be blanked off to the sides, roof and floor and properly sealed to minimize filter bypass
1. Pre-filter sections shall be factory fabricated as an integral part of the air handling unit. Filters shall be arranged for face loading into a gasketed Universal holding frame. Filters to be Aerostar Series 400, MERV-8, UL Class 2 (min.), made from 100% Synthetic media as manufactured by Filtration Group. (1) construction set and (1) additional set of the filters are to be provided.
 2. ~~Intermediate and/or High Efficient~~ Final filters. The filter section shall be factory fabricated as an integral part of the air-handling unit. Filters to be arranged for face loading into a gasketed positive sealing Universal Holding Frame. Filters to be model FMV, MERV-14, UL Class 2 (min.), as manufactured by Filterair. Initial pressure drop shall not exceed 0.31" at 500 fpm face velocity. (1) construction set and (1) additional set of the filters are to be provided.
 3. ~~HEPA Filters. The HEPA filter section shall be factory fabricated for Face Loading of the filters in the proper HEPA Filter Frame matched to the filter. Filters to be Aerostar model HV, 99.97% DOP Efficient, MERV 17, UL Class 2 (min.), as manufactured by Filtration Group. Initial pressure drop shall not exceed 0.83" at 500 fpm face velocity. Filters shall have a minimum filter media area of 110 Sq. Ft. per Sq. Ft. of filter face area. (1) construction set and (1) additional set of the filters are to be provided.~~
 4. Each filter bank to be provided with a Dwyer Series 605, Magnehelic Indicating Transmitter. Transmitters to be flush mounted. Exterior unit transmitters to be covered with a weatherproof enclosure to protect the gauge and prevent hazing of the glass.
 5. Provide walk-in filter access sections upstream downstream of each filter rack with adequate space for filter service.
 6. Filter banks to be sized so maximum filter face velocity does not exceed 500 fpm.
 7. Filter efficiencies shall be based on ASHRAE Standard 52.1 – 1992 or ASHRAE Standard 52.2 - 1999.

2.13 LIGHTS/CONTROL WIRING:

- A. Provide vapor proof marine type 27-watt flourescent light fixtures in each accessible section complete with a protective metal cage and sealed glass enclosure. Lights to be wired to a common switch mounted in a weatherproof box adjacent to the fan access door complete with a convenience outlet. Outlet shall have an indicator light. ~~Power shall be 120v/1/60.~~
- B. All wiring to lights shall be in conduit and internal to the unit. No external conduit runs for the lights are allowed.
- C. Air handler manufacturer shall allow a minimum 1.5" clearance above the entire width of each interior bulk headers (coils, filters, fan blank off, etc.). This will be to allow wiring of any 110v or 24v runs internally to the unit as required by the controls contractor and reduce the number penetrations of the exterior panels.
- D. If the unit requires splitting, junction boxes shall be furnished at each section to allow the electrical contractor to make final connections in the field. Wiring shall be clearly labeled at junction points to facilitate reconnection.

2.14 LOUVERS:

- A. Furnish and install, where shown on the plans, or in accordance with the schedules, a louver of the stationary Drainable Blade type with a drain gutter in each blade and downspouts in the frame jambs and mullions. Louvers shall have a minimum 57% free area based on a 48" wide x 48" high size. The stationary blades shall be contained within a 6" frame. Frame and blade material shall be 6063-T5 aluminum alloy. Frame shall contain integral caulking slots. A $\frac{3}{4}$ " x 0.51" expanded, flattened aluminum bird screen shall be included and contained within a removable frame.
- B. Louver design shall limit span between visible mullions to 10 feet and shall incorporate structural supports to withstand a wind load of 20 lbs. per square foot (equivalent to a 90-mph wind).
- C. Published louver performance data must be submitted for approval demonstrating pressure drop and water penetration. Louver to be AMCA Standard 500 certified and licensed to bear the AMCA Seal.
- D. Louver Sizing:
 - 1. OSA: 600 (500) fpm maximum face velocity
 - 2. Exhaust: 1100 (900) (750) fpm maximum face velocity

2.15 DAMPERS:

- A. Control Dampers: Furnish and install, at locations shown on plans, or in accordance with schedules, Standard (Low Leak) Dampers with published leakage data certified under the AMCA certified ratings program. (Low Leak Dampers shall be rated less than 6.2 cfm per sq. ft. of area at 4-in. w.g. pressure difference through a 48" x 48" damper). Published leakage data shall include leakage information for all available damper sizes at pressure differences from 1 in w.g. through 13 in w.g. Standard Control Dampers shall be constructed of Formed Steel (extruded Aluminum) blades and casing provided with vinyl or rubber edge seals and stainless steel edge seals. (Low leak dampers shall be fabricated of minimum 5" x 1" x .125" 6063T5 extruded aluminum hat channel with hat mounting flanges on both sides of the frame. Blades shall be airfoil type extruded aluminum (maximum 6" depth) with integral structural reinforcing tube running the full length of each blade. Blade edge seals shall be extruded vinyl double edge design with inflatable pocket that enables air pressure from either direction to assist in blade to blade seal. Blades shall be mechanically locked in extruded blade slots, yet be easily replaceable in the field.) Adhesive or clip-on type blade seals are not acceptable. Bearings shall be non-corrosive molded synthetic. Axles shall be square or hexagonal (round is not acceptable) to provide positive locking connection to blades and linkage. Linkage shall be concealed in the frame.

2.16 HUMIDIFIERS (AH-23):

- A. Steam generators shall be provided separate of air handling unit. Dispersion tube array shall be provided by air handler manufacturer.
- B. Dispersion tube array shall be constructed of stainless steel.
- C. Dispersion tube array shall be maintenance free. Gaskets, o-rings, etc. shall not be used, ~~no exceptions.~~

- D. Dispersion tube array shall use an injection tube design. ~~Tube in tube (jacketed) designs shall not be used due to their inherently lower efficiencies.~~
- E. Air handler manufacturer shall be responsible for allowing enough absorbtion distance to prevent wetting of interior surfaces downstream of the drain pan.

2.17 UV LIGHT PACKAGE:

- A. Factory provided and installed UV Light Package with control and safety interlock arranged toward downstream side of chilled water cooling coil.
- B. Factory wired with electrical power connection point for field installation.
- C. Fixture housing and lamp shall be of the double-ended lamp type and be factory assembled and tested. Each UVC device shall consist of a housing, power supply, fixture cover, lamp sockets, and lamps and shall be constructed to withstand the interior environments of HVAC equipment. Fixture assemblies are to be Model DEF Standard Output series as manufactured by UV Resources.
- D. Housing shall be constructed of CNC cut and punched 20GA stainless steel to incorporate the Power Supply, Housing Cover, Lamp Sockets and Lamp into one integral assembly that maximizes serviceability. Housing shall be equipped with 6- 1/2" electrical knockouts (3- each end) and pre-punched mounting holes to facilitate proper installation.
- E. Power Supply shall be of the High Power Factor, Class P, Sound Rated A, Type 1 Outdoor type with End of Lamp Life and Inherent Thermal Protection in accordance with FCC Part 18. The power source shall automatically optimize power output for any 420ma lamp of any length of between 22" – 36", to be capable of lighting and maximizing radiance from each lamp in temperatures ranging from 1° to 70° C, and airflow velocities to 1000 fpm.
- F. Lamp Sockets shall be medium bi-pin type as specified. They shall be constructed of pre-cast polycarbonate and UL Listed and rated for 600 V, 130° C.
- G. Fixture Cover shall be constructed of CNC cut and punched 20GA stainless steel to enclose the Power Supply and be removable for inspection or service.
- H. Lamps shall be of the standard output, hot cathode, T5 (15mm) diameter, double-ended mini bi-pin type. They shall produce no ozone and provide an initial minimum UVC transmittance of 83%. Filaments shall be triple-coiled, tungsten coated, clamped-filament type to enhance plasma stability and longevity. Lamp bases shall be constructed of UV resistant materials to eliminate deterioration. Lamps shall provide the specified output at airflow velocities to 1000 fpm and temperatures of 1-70° C.
- I. Independent Testing as submitted shall have been performed by UL to be Listed and labeled as UL/C-UL under Category Code ABQK (Accessories, Air Duct Mounted), UL Standards: 153, 1598 and 1995 respectively. When test instruments are calibrated in accordance with the provisions of IES Lighting Handbook, 1981 Applications Volume; output per inch of lamp arc length shall not be less than 3.5 $\mu\text{W}/\text{cm}^2$ at 1 meter in moving air of 45° F and 400 fpm.

2.18 AIR FLOW MEASURING STATIONS

- A. Provide each supply fan and each return/relief fan with airflow traverse probes mounted in the fan inlet cone capable of continuously measuring the airflow capacity (air volume) of the respective centrifugal fan.

1. The fan inlet airflow traverse probes shall contain multiple total and static pressure sensors placed at concentric area centers along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds. Sensors shall not protrude beyond the surface of the probe, nor be adversely affected by particle contamination normally present in building system airflows. Velocity sensing range of 350 – 8500 fpm.
 2. The fan inlet airflow traverse probes (two per inlet) shall have dual end support swivel brackets suitable for mounting in the fan inlet bell and symmetrical averaging signal takeoffs and fittings, and shall be of aluminum construction with hard anodized finish. Sensing probes to be factory mounted.
 3. The fan inlet airflow traverse probes shall not induce a measurable pressure drop, nor shall the sound level within the system be amplified by its presence in the fan inlet bell. The probes shall be capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors, with an accuracy of 3% of actual flow over a fan operating range of 10 to 1 capacity turndown.
- B. Provide a direct linear electronic output signal, 4-20 mA, calibrated to CFM for interface by the Temperature Control Contractor to indicate fan air volume at the BAS. Unit shall be factory calibrated and rechecked in field.
- C. Unit to include probe electronic enclosure, transmitter and 25'-0" of cable shipped loose for field installation. Input power required, 24 volts AC.
- D. Acceptable Manufacturers: Tekair Systems VorTek Model VT-7000 or equal.

2.19 CONTROLS

- A. Provide each unit ready to receive direct digital controls (DDC) according to Sections 23 09 93. Submit electrical requirements for power supply wiring and a ladder type wiring diagram. Clearly differentiate between factory and field wiring on the submittal information.

PART 3 - EXECUTION

3.1 DELIVERY

- A. Ship units with 4 mil poly shrink wrap completely covering each component shipped separately.

3.2 INSTALLATION

- A. Bolt all sections together to form a rigid, air tight assembly. Assemble the units according to SMACNA standards and install all components in accordance with the manufacturer's written recommendations.
- B. Field assemble each unit on a (4) or (6) inch concrete housekeeping pad.
- C. Install filters in the housings where shown and as described in Section 23 41 33, Air Filtration.
- D. Provide factory lifting lugs, spreaders, and cables when rigging.

3.3 COORDINATION

- A. Coordinate with the suppliers of variable frequency controllers and controls to provide any information required by them to complete their installations.
- B. Provide 3-D AutoCAD drawing electronic data available to the Contractor, scaled and sized to jobsite conditions to provide As-Built record documentation.
- C. Coordinate the installation of the humidifier panel with the supplier.

3.4 VARIABLE FREQUENCY CONTROLLERS

- A. Coordinate with the suppliers of variable frequency controllers and controls to provide any information required by them to complete their installations.

3.5 AIR FLOW MEASURING STATIONS

- A. Temperature control contractor is responsible for the following:
 - 1. Install probe electronic enclosure and transmitter outside of air handling unit.
 - 2. Extend cables from the probe electronic enclosure and transmitter to the airflow probes.
 - 3. Provide 24 volts AC to the probe electronic enclosure and transmitter.
 - 4. Output signal shall go to BMS for CFM indication.

END OF SECTION

SECTION 23 81 23

COMPUTER ROOM AIR CONDITIONING UNITS - UNITARY CEILING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Packaged air conditioners for spot cooling.

1.2 QUALITY ASSURANCE

- A. Products to be UL or ETL listed and conform to requirements of applicable codes.

1.3 SUBMITTALS

- A. Submit shop drawings and product data in accordance with General Provisions.
- B. Submit manufacturer's descriptive literature, operating instructions, and maintenance and repair data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Daikin, Data Aire, or Liebert, or approved equal.

2.2 PACKAGED CONDITIONERS FOR SPOT COOLING

- A. ~~Equal to Liebert mini-Mate as called out on drawings.~~
- B. ~~Basic unit to be a packaged precision conditioner for spot cooling. Configuration to be horizontal for ceiling mounting and sized to fit the 2 Ft. x 4 Ft. opening of a standard "T-bar" ceiling. Capacity shall be 50,000 BTUH at 72° F. DB, 60° F. WB entering air.~~
- C. Service access to be through hinged filter and grille frame at the bottom of unit. Airflow shall be vertical through aluminum outlet and inlet air grilles. Double inlet, direct drive, dynamically balanced blower with multiple forward curved blades. Unit shall have disposable filters. Cabinet to be zinc coated steel, with primer coat and baked enamel finish, insulated with 1/2 inch x 2 pound density fiberglass insulation. Vibration isolators shall be an integral part of the cabinet. Frame shall be heliarc welded aluminum extrusion for maximum strength and reduced weight.
- D. Refrigeration system is to be completely prepped using Type "L" copper, and shall include thermostatic expansion valve with external equalizer, sight glass, filter-dehydrator and access fittings on the suction and liquid lines. The hermetic compressor shall be provided with vibration mounting springs, line break internal protection system, forced feed lubrication, and internal pressure relief valve. Evaporator coil shall have multiple circuits for efficient heat transfer and low pressure drop, and be manufactured with seamless copper tubes and mechanically bonded aluminum fins.
- E. Electrical components, including contactors, relays, control transformers and capacitors shall be prewired. Terminal blocks shall be provided for both control and power connections. A

moisture detector type sensing device shall be installed at the evaporator drain pan to stop unit operation prior to an overflow condition.

- F. Control system shall be completely solid-state. The thermostat and on-off switch shall be wall mounted.
 - 1. The condensing unit module shall be located on the roof with precharged refrigerant lines between evaporator and condensing unit modules.
- G. Condensate Pump: Provide condensate pump to dispose of condensate from cooling coil, piped as shown on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide water and drainage piping for water cooled units and for humidifier flushing system.
- B. Install unit(s) in accordance with manufacturer's instructions.

END OF SECTION

SECTION 23-82-39

HEATING TERMINAL UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. ~~Constant Air Volume Terminal Units with Reheat Coils~~
- B. ~~Electric Radiation~~
- C. ~~Radiant Panels~~

1.2 QUALITY ASSURANCE

- A. ~~Provide the products of manufacturers regularly engaged in the production of equipment Specified.~~
- B. ~~Provide electric heaters and all required panelboards that meet the requirements of the National Electric Code and that are UL listed for zero clearance to combustible surfaces.~~

1.3 SUBMITTALS

- A. ~~Shop Drawings: Submit shop drawings on all equipment provided under this Section. Include performance data based upon the design conditions shown in the schedules on the Drawings. Include catalog data to verify that they are the products of a company regularly engaged in their manufacture. For all exposed products such as covers, cabinets and enclosures, submit finished sample section for color matching and approval by the Architect.~~
- B. ~~Radiant Panel Shop Drawings: With radiant ceiling panel shop drawings, include floor plans and details to illustrate how the panels will be laid out and coordinated with the ceiling system. Provide reflected ceiling plans drawn to at least 1/8 inch = 1'-0". Indicate whether the panels will require field cutting. Include written installation instructions.~~
- C. ~~Finned Tube Shop Drawings: Before fabrication, submit drawings and samples of all custom enclosures for approval by the Architect.~~

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. ~~Electric radiation: Berke, Electromode, Markel Chromalox.~~
- B. ~~Radiant panels: Airtex, Aztec, Shelley or approved equal.~~

2.2 PERFORMANCE

- A. ~~Hydronic Systems: Unless noted otherwise, base heating capacities on 65° F. entering (or room) air temperature, and 180° F. average water temperature. Unless noted otherwise, assume the water temperature differential for all units will be 30° F.~~
- B. ~~Electric Systems: Unless noted otherwise, base heating capacities on 65° F. entering (or room) air temperature.~~

2.3 — RADIANT PANELS

- A. — ~~Equal to the Radiant Acoustical Modular heating panels manufactured by Airtex Corporation.~~
- B. — ~~Panels: Provide rigid, linear, extruded aluminum face plates at least 0.095 inches thick with a V-grooved or channel grooved surface. Mechanically bond 1/2 inch copper serpentine tubing to the face plate so that over half of the tubing diameter is enclosed by the aluminum. Adhesives, clips or other mechanical fasteners are not an acceptable means of fastening tubes to face plates. Apply a nonhardening, heat conductive paste between the tubing and the face plate. Unless noted otherwise, provide 2 by 2 foot panels in the configurations shown on the Drawings. Provide panels compatible with the lay in ceiling system and painted at the factory with a semi-gloss finish that matches the finish on the T-bar grid.~~
- C. — ~~Insulation: Cover the top of all panels with at least 1 inch thick, 3/4 pound density, glass fiber pads.~~
- D. — ~~Piping: The factory shall install the tubing in the panels along with all the 360-degree tubing returns and U-bends to complete the piping integral with the panels. Each panel shall be delivered to the job site requiring only a supply and a return piping connection. The factory shall also supply the Contractor with all the U-bends or pigtails needed to connect consecutive panels without custom fabrication of tubing or fittings. The tube wall thickness shall be at least 0.02 inches. The tube ends shall be compatible with the standard wrought copper fittings for soldered connections used throughout the heating water piping system.~~
- E. — ~~Performance Requirements:~~
 - 1. — ~~Each 2 by 2 foot radiant-acoustical panel shall produce at least 1800 BTUH of heating output.~~

PART 3 — EXECUTION

3.1 — GENERAL INSTALLATION

- A. — ~~Install each unit in accordance with the manufacturer's written instructions.~~
- B. — ~~Anchor heating water supply and return risers as shown on the Drawings and specified in Section 23-05-10. Provide swing joints at the top and bottom of heating water risers to allow 1-inch of thermal movement.~~
- C. — ~~Provide accessible, manual vents at the high points for each unit. If a vent location is not accessible, extend the vent to the exterior surface of the cabinet.~~

3.2 — RADIANT PANELS

- A. — ~~Field Cut Panels: If panels must be field cut for final fitting, the Mechanical Contractor shall use forces with experience and qualifications for doing finish millwork, ceiling panel installation or carpentry, not pipe fitters. The installing tradesmen shall also be trained and approved by the manufacturer of the panels to verify that they know how to install the panels so they do not buckle or leak, and so they will operate quietly and reliably. All raw cut edges shall be enclosed behind a T-bar or concealed in some other way to provide a finished appearance. Butt edges will not be accepted. Allow space at each end of each panel for thermal expansion and contraction.~~
- B. — ~~Piping Connections: All piping connections shall be made by pipe fitters. Each panel assembly's tubing system shall be pressure tested by the panel installer before it is turned~~

~~over to the Mechanical Contractor's piping crew for connection to the building's heating water piping system. Test each panel system at 100 PSIG or 1-1/2 times the normal operating pressure, whichever is greater, for at least 24 hours. After connection to the heating water piping system, test all the panels again as an integral part of that piping system. Refer to Section 23 05 93 for the testing procedure required for that system. If the panel installer is a separate subcontractor, and if any part of the panel system leaks during the heating water piping system tests, the panel installer shall repair all leaks in his installation and repair all damage caused by his leaks. After these repairs are complete the Mechanical Contractor shall retest the heating water piping system. If the panel system leaks again during the second test, the panel installer shall repair all his leaks and damages and then pay for all subsequent tests and repairs required to finally qualify the entire heating water piping system.~~

- ~~C. The Mechanical Contractor shall furnish and install all run-outs, valves, air vents, fittings and accessories required for connection of the radiant panels to the heating water piping system. If the panel installer is a separate subcontractor, the Mechanical Contractor shall allow the panel installer to witness and direct the connection of the radiant panels to the heating water piping system to see that it is done in strict compliance with the manufacturer's written recommendations and in a manner that will not cause leaks or damage to the system. The Mechanical Contractor shall not proceed with this work if the panel installer is not present unless he has a written notification that the panel installer waives his right to direct this work.~~

~~END OF SECTION~~

SECTION 23 84 13

HUMIDIFIERS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. ~~Provide steam grid humidifiers for connection to the [humidification] steam piping system.~~
Provide humidifiers complete with distribution manifolds and control valves.
- B. ~~Provide rotating disc humidifiers.~~

1.2 QUALITY ASSURANCE

- A. Units shall be ETL and cETL listed.
- B. AGA (American Gas Association).
- C. CGA (Canadian Gas Association).
- D. CSA (Canadian Standards Association).

1.3 SUBMITTALS

- A. Submit product data (manufacturer's specifications, and technical data including performance, construction and fabrication) for each manufactured component. Refer to Section 23 05 00 for Shop Drawing Submittal requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Steam Grid Humidifiers: Armstrong, Dri-Steem, Clark-Reliance, Herrmidifier, Pure Humidifier Co.

2.2 STEAM GRID HUMIDIFIER DESCRIPTION

- A. ~~Equal to Armstrong Series 9000 of sizes noted on the drawings.~~
- B. Each steam humidifier shall provide pneumatic, modulating control. Provide humidifiers capable receiving steam at a supply pressure of 5 psig and discharging at atmospheric pressure. The device shall have a separating chamber upstream of a control valve. The control valve shall discharge through an internal, steam jacketed drying chamber, silencing chamber and steam jacketed distribution manifold.
- C. The separating chamber shall disengage and remove all water droplets and all particulate matter larger than 3 microns while the humidifier is operating at full capacity.
- D. The control valve shall be integral within the body of the humidifier and shall be jacketed by steam at supply pressure and temperature to prevent condensation. It shall have a parabolic plug configuration capable of full, accurate modulation of steam flow over its entire stroke. The valve stroke shall be at least 3/4 inch.

- E. The internal drying chamber shall receive steam at nearly atmospheric pressure and shall be jacketed by steam at supply pressure.
- F. The silencing chamber shall be steam jacketed and shall utilize a stainless steel silencing medium. Provide a temperature switch with each humidifier to prevent "spitting".
- G. The distribution manifold shall provide uniform distribution over its entire length and shall be jacketed by steam at supply pressure to assure that the vapor discharge will be free of water droplets. Provide each manifold with a full length, stainless steel, internal silencing screen.
- H. Vapor trail of humidifier shall not exceed (5) feet. Provide correct number of manifolds to meet the vapor trail requirement.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Steam Grid Humidifiers:
 - 1. Install per manufacturer's printed instructions and as indicated on drawings.
 - 2. Provide galvanized steel rods to support the distribution manifolds. Mount them in air system plenums. Coordinate the locations to be sure the ductwork at the humidifier locations includes a shallow pan soldered water tight and equipped with a drain pan and a trapped drain pipe to a floor drain. No duct lining shall be used within twenty feet of a dispersion tube. Instead, this section of ductwork shall be wrapped.
 - 3. Connect each unit's steam supply. Provide a gate valve, inlet strainer and external inverted bucket steam trap at each connection. Refer to Section 23 22 00.
 - 4. Connect each unit's condensate piping.
 - 5. Provide any information requested by the Temperature Control Contractor as he installs and connects the pneumatic humidity controllers. Refer to Section 23 09 00.

END OF SECTION

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This SECTION describes the requirements for furnishing and installing chain link fencing and gates including but not limited to:
 - 1. Excavation, backfilling, and other earthwork for posts.
 - 2. Associated concrete Work.
 - 3. Chain link fences, gates, and accessories.

1.02 QUALITY ASSURANCE

- A. Qualifications, Installer: Company specializing in the installation of chain link fences and gates of the types required with not less than five (5) years continuous experience prior to the date of this Project.
- B. Reference Standard: Materials and installation shall be in compliance with applicable requirements of CLFMI "Standard Guide for Metallic-Coated Steel Chain Link Fence and Fabric" (hereinafter called "CLFMI Product Manual").
- C. Design Criteria:
 - 1. Fencing:
 - a. Layouts: As indicated.
 - b. Heights: As indicated.
 - c. Framing: Steel, including but not limited to posts, top and bottom rails, post brace assemblies, metal fabrications, and related accessories.
 - 2. Gates: Swing type, sizes, configurations, swing directions, and locations as indicated. Match height of fencing.
- D. Regulatory Requirements: Materials and installation shall be in compliance with requirements of the applicable building code and other regulations. Refer to SECTION 01 41 00 "REGULATORY REQUIREMENTS" for further information.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's descriptive and technical data and illustrations, clearly marked to show specific products, materials, finishes, and compliance with specified requirements. Include manufacturer's printed installation instructions.
- B. Shop Drawings: Submit Shop Drawings showing materials and thicknesses and details of fabrication and installation including anchorages, connections, welds, fasteners, hardware, and attachment to other Work.

- C. Color Samples: Submit samples of privacy slats for Architect's color selection.
- D. Maintenance Data: Furnish manufacturer's printed recommendations for the care and maintenance of fencing and gates to the Owner.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect materials from damage during transportation, storage, and field handling.
- B. Deliver metal items requiring anchorage built into concrete to the Site with complete setting diagrams, measurements, and instructions.
- C. Store products elevated above the ground and concrete slabs in a clean, secure location, protected from construction activities until ready for use in the Work.
- D. Comply with additional requirements of the manufacturer and referenced standards.

1.05 COORDINATION

- A. Coordinate installation of fencing to avoid substantial interference with Work of other SECTIONS or separate contracts.
- B. Coordinate disposal of surplus excavation with earthwork grading requirements, and as specified hereinafter.
- C. Coordinate pipe sleeves for fence posts to be supported by concrete walls, slabs, or other concrete with concrete Work provided under other SECTIONS.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with specified requirements, furnish chain link fencing and gates as manufactured by Anchor Fence, Inc., Cyclone Fence, or accepted equal.

2.02 FENCING AND GATE COMPONENTS

- A. Fabric: 2-inch diamond mesh with 0.148-inch diameter (nominal 9-gauge) steel wire in compliance with ASTM A392 with Class 2 zinc coating before weaving into fabric and with edges knuckle closed at both selvages. Coat selvage ends with manufacturer's standard clear protective coating. Furnish fabric in one-piece heights measured between top and bottom of outer edge of selvage.
- B. Framing: Round steel pipe in compliance with CLFMI Product Manual, Type II (ASTM F1043, Group IC with yield strength not less than 50000 psi), sizes as required for fence heights and spacing and gate sizes.
- C. Gates:
 - 1. Components:
 - a. Perimeter Frame: As specified for fencing.

- b. Hinges: Manufacturer's heavy duty malleable iron, non-lift-off type, offset to permit 180 degree gate opening, size as recommended by the manufacturer to suit gate size.
 - c. Diagonal Bracing: Manufacturer's standard to ensure rigidity without sag or twist.
 - d. Latches:
 - 1) Single Gates: Forked type or plunger bar type to permit operation from either side of gate with padlock eye as an integral part of the latch. Coordinate size of padlock eye with shank diameter of specified padlock.
 - 2) Double Swing Gates: Lathing device with steel drop rod or plunger bar to permit operation from either side of gate with a single padlock eye as integral part of latch, and arranged to engage gate stop. Coordinate size of padlock eye with shank diameter of specified padlock.
 - e. Gate Stops: Steel pipe to accept drop rod or plunger, suitable for setting in concrete. Furnish at all double swing gates.
 - f. Gate Keepers: Mechanical device for securing free end of gate when in full open position. Furnish for each gate leaf over 5-feet wide.
 - g. Padlocks: Furnished and installed by Owner.
2. Fabrication:
- a. Fabricate gates to match fencing in accordance with ASTM F900 for single and double swing gates.
 - b. Fabricate frames with horizontal and vertical members accurately fitted, formed, and continuously welded to ensure proper gate operation and attachment of fabric, hardware, and accessories. After fabrication, touch-up welds with zinc-rich repair paint in compliance with ASTM A780.
- D. Fittings and Accessories: Provide steel fittings and accessories in compliance with ASTM F626, ASTM F1916, and as specified. Furnish fittings and accessories for complete fencing and gate installation including, but are not limited to stretcher bars and bands, bracing struts, post caps, rail sleeves, tie wire, hardware, and fasteners.
- 1. Rail Sleeves: Internal round steel tubing couplings, approximately 6-inches long with not less than 0.070-inch wall thickness. Furnish for each joint for connecting lengths into a continuous run.
- E. Privacy Slats: Polyethylene tubular slats, not less than 0.023-inch thick, manufactured for chain-link fences from virgin polyethylene containing UV inhibitor, sized to fit and be self-locking with specified fence fabric and installation direction specified, and with integral "wings" for increased screening and security. Furnish in color as selected by the Architect from the manufacturer's full range; one color will be used throughout.

- F. Fencing Finishes:
1. Steel Fence and Gate Framing Components:
 - a. External Coating: Hot-dipped galvanized in compliance with ASTM F1043, Type B.
 - b. Internal Coating: Hot-dipped galvanized in compliance with ASTM F1043, Type B.
 2. Fabric: As specified hereinbefore.
 3. Stretcher Bars, Rods, Hardware, Fittings, Fasteners, Ties, and Accessories: Hot-dip galvanized in compliance with ASTM A153 with weight of zinc coating not less than Table 1.
 4. Miscellaneous Steel Items: Hot-dip galvanized as specified in SECTION 05 50 00 "METAL FABRICATIONS".
- G. Expansion Bolts: Hilti, Inc. "Kwik Bolt TZ", or accepted equal, fabricated of AISI Type 304 stainless steel. Provide types suitable for specific Work required; furnish diameters and embedded lengths as indicated.
- H. Zinc-Rich Paint: In compliance with SSPC Paint 20 and regulatory requirements.
- I. Concrete: As specified in SECTION 03 30 00 "CAST-IN-PLACE CONCRETE", or comparable as proposed and accepted.

2.02 FABRICATION

- A. General Requirements: Shop-fabricate fence gates, posts with mounting plates, and other miscellaneous steel items in accordance with the accepted Shop Drawings and as specified.
- B. Miscellaneous Steel Items: In addition to general requirements, fabricate miscellaneous steel items in compliance with SECTION 05 50 00 "METAL FABRICATIONS".
- C. Posts with Steel Mounting Plates: Fabricate posts with steel plates of required sizes, shapes, and thicknesses, continuously welded to the bottom of posts. Furnish posts with mounting plates for installation locations over the tunnel and for other locations indicated.
- D. Gates:
1. In addition to general requirements, fabricate gates to match fencing in compliance with ASTM F900.
 2. Fabricate frames with horizontal and vertical members accurately fitted, formed, and continuously welded to ensure proper gate operation and attachment of fabric, hardware, and accessories. After fabrication, touch-up welds with zinc-rich repair paint in compliance with ASTM A780.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify that conditions are satisfactory for the installation of chain link fencing.
- B. Do not begin installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection:
 - 1. Protect adjacent surfaces and finishes from damage during installation of fencing and gates.
 - 2. Protect products and materials from damage during field handling and installation.
 - 3. Protect posts from concrete splatter.
- B. Layouts:
 - 1. Locate posts in straight alignment, uniformly spaced as specified and as indicated.
 - 2. End panels of a run may be incrementally adjusted when necessary to accommodate any odd dimensions while maintaining uniformity of appearance as intended.
 - 3. Establish rail heights respective to indicated finish grades, not rough grades.

3.03 EXCAVATION AND FORMING

- A. Post Holes:
 - 1. Excavate to not less than post-base size and depth indicated.
 - 2. When clay, soft, yielding, or sloughing soil is encountered, either:
 - a. Well over-excavate, refill using suitable soil compacted in layers as placed, and excavate hole as required, or
 - b. Over-excavate, provide suitable forms for concrete; and, after concrete is placed and hardened sufficiently, remove forms and backfill using suitable soil well compacted into place.
 - 3. Remove loose soil and level hole bottom before placing concrete.
- B. Surplus Excavation:
 - 1. When there is deficient local material to provide earthwork rough grades as required in vicinity of fencing, dispose of surplus excavation by uniformly spreading and leveling out along and on both sides of fencing alignment.
 - 2. Otherwise, dispose of surplus excavation off Site.

C. Posts and Post Bases:

1. Where tops of concrete post bases are indicated at finish grade but when lower rough grades only are to be provided under the Contract, provide suitable forms as required to form upper sections of bases which will remain exposed until finish grades are developed. Remove forms after concrete has sufficiently hardened.
2. Place and consolidate concrete free from voids, shape tops to drain away from posts; and steel trowel to neat and smooth condition.
3. Allow concrete for posts to attain at least 75 percent of its minimum 28-day strength before installation of remainder of framing and fabric.

3.04 INSTALLATION

A. General Requirements: Install chain link fences and gates in compliance with the manufacturer's printed instructions, accepted Shop Drawings, ASTM F567, as indicated, and as specified.

B. Posts:

1. General Requirements:

- a. Ensure that correct posts are installed in correct locations and provide required clearances. Center and align posts in holes above bottom of excavation as indicated.
- b. Set post plumb, accurately aligned, and at correct height and position. Check each post for vertical and top alignment. Temporarily brace in position during concrete placement, finishing, and curing operations.
- c. Place and consolidate concrete free from voids, shape tops to drain away from posts; and steel trowel to neat and smooth condition.
- d. Allow concrete for posts to attain at least 75 percent of its minimum 28-day strength before installation of remainder of framing and fabric.
- e. Install post caps as soon as possible after setting posts to ensure posts will be free of debris and moisture.

2. Corner and Pull Posts: Install corner and pull posts where changes in direction exceed 30 degrees.

3. End Posts: Install end posts to provide closure to within 1/4-inch of buildings and walls.

4. Line Posts: Install line posts, evenly-spaced not to exceed 10-feet on center.

5. Gate Posts: Install gate posts at each side of each gate.

C. Top and Bottom Rails:

1. Install top and bottom rails level, in one-piece between posts, and flush with post on fabric side using rail end fittings; furnish special offset fittings where necessary.

2. Install rail sleeves at rail joints and incorporate rail-end gaps to compensate for thermal expansion contraction at not over 20-feet on center.
- D. Bracing Panels:
1. For fencing runs with less than two line posts, bracing shall consist of horizontal intermediate rail sections only for each fence panel.
 2. For fencing elsewhere, each bracing panel shall consist of horizontal intermediate rail section and sloped truss rod.
 3. At any two adjacent bracing panels, slope truss rods in opposite directions.
 4. Provide bracing panels at locations as follows:
 - a. Adjacent to each gate post.
 - b. Each side of each corner post.
 - c. Each side of each line post where fence alignment changes to 160 degrees or less.
 - d. Adjacent to each terminal end post.
 - e. Each side of most central line post for any single straight fence run exceeding 150-feet, and at not less than 100-feet on center for runs 200-feet and greater.
- E. Fittings and Accessories: Install fittings and accessories in compliance with the manufacturer's printed instructions. Install fasteners with lock nuts on secured side of fence.
- F. Fabric:
1. Install fabric on the non-secured side of framing. Pull fabric taut and tie to posts and rails and anchor to framework so that fabric remains taut and in tension after pulling force is released.
 2. Join adjacent rolls of fabric by weaving a strand of fabric through the ends of rolls to form a continuous mesh.
 3. Secure fabric to end, corner, pull, and gate posts using stretcher bars threaded through or clamped to fabric at 4-inches on center. Secure stretcher bar bands, bolted 12-inches on center, to posts.
 4. Wire tie fabric to rails near terminal ends or corners and at not over 24-inches on center in between.
 5. Wire tie fabric to posts near bottom edge and vertically at not over 24-inches on center.

G. Gates:

1. General Requirements:

- a. Install gates and hardware so gates are plumb, level, and secure for full opening without interference.
- b. Adjust and lubricate hardware for smooth and quiet operation.
- c. Install gate stops in 6-inch diameter concrete-filled holes to footing depth.

2. Swing Gates:

- a. Provide adequate operational clearances so gates operate freely.
- b. Ensure that there is no more than a 2-inch gap between sides of gate and gate opening when gate is closed.

H. Finish Touch-Up: Touch-up welded areas, nicks, scratches, and other damage to galvanized finish with specified touch-up paint in compliance with ASTM A780 and the paint manufacturer's printed instructions.

I. Privacy Slats: Install privacy slats vertically in fence and gate fabric to completely fill all openings and achieve 90 percent wind load and privacy factor. Set slats to uniform height and position.

3.05 COMPLETION

- A. When complete, chain link fencing shall be set square, plumb and level, accurately aligned, and with all components securely anchored to prevent movement.
- B. Fabric shall be uniform to plane, taut, and free from sags, warps, and bulges.
- C. Surfaces shall be clean and free from scratches, dents, tool marks, stains, discoloration, and other defects and damage.
- D. Gates shall swing smoothly and quietly and shall free from binding through the full range of travel.

3.06 PROTECTION

- A. Protect chain link fencing from damage and deterioration until time of completion and acceptance by the Owner.

END OF SECTION